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Molding the 1917 Eight-Cylinder Cadillac Motor

How Cylinder Castings, Having 5-32-Inch Jacket Walls, Are Successfully Cast in Dry Sand Three-Part Molds—Withstand High Test Pressures

By H Cole Estep

ONE of the striking features in the development of the American automobile has been the constantly diminishing ratio between weight and horsepower. Our cars today are lighter than ever, consistent with strength, and at the same time are much more powerful than they were a few years ago. These results could not have been achieved without the active cooperation of foundrymen specializing in automobile work. In coping with the problem of unnecessary weight in particular, automobile engineers have thrown a constantly increasing burden on the casting plants. Each successive motor design, for instance, has called for cylinder and jacket walls of appreciably decreased thickness, but at the same time it has been necessary to maintain strength and density. No concern building automobiles has been more active in the encouragement of refinements of this nature than the Cadillac Motor Car Co., Detroit. These refinements have reached their zenith in the development of the eight-cylinder motor with which the 1917 Cadillac car is equipped and in this effort the Cadillac company's foundry has played no inconspicuous part. An illustrated article

FIG. 1—GENERAL VIEW OF POURING FLOOR AT CADILLAC FOUNDRY SHOWING METHOD OF ASSEMBLING MOLDS FOR EIGHT-CYLINDER ENGINE

describing in detail the methods employed in molding and casting the cylinders for the 1916 Cadillac eight was published in the May, 1915, issue of *The Foundry*. Since that time a number of improvements have been made in the Cadillac foundry, which, together with certain slight but, from a foundryman's standpoint, pertinent changes in the design of the motor, have occasioned the adoption of an entirely new method of molding.

Originally each set of four cylinders was cast *en bloc* in green sand

FIG. 2 — THE FIRST STEPS IN THE CORE ASSEMBLING OPERATION

in a 15½ x 28-inch two-part flask. The drag was 10¾ inches and the cope 7 inches in depth. The cylinders were cast with the crank-case end down, the heads, which are not removable, extending into the cope. Comparatively speaking, the method of procedure was simple.

Satisfactory castings in sufficient quantity for the needs of the company were produced by this method although some trouble was experienced in avoiding losses due to the inevitable, slight irregularities in ramming green sand molds, as well as in the temper of the sand itself.

The designs for the 1917 motor include a reduction in jacket wall sections from 7/32 to 5/32-inch, although the hydrostatic test pressures of 100 pounds per square inch in the foundry and 200 pounds after machining have not been altered. Owing to the narrow limits imposed by the new design, as well as on account of the difficulties that have been suggested, it was decided to change the system of molding to a dry-sand basis.

At present, therefore, the molds are oven dried to a depth of about 2 inches before being assembled and poured. Also, in order to insure sound cylinder heads, the job has been turned end for end and the block is now poured with the crank-case end up. This change has necessitated the adoption of a three-part flask, in order to get the pattern out of the sand. Only the drag and cheek, however, are dried. The cope which is simply a cover containing the dry-sand pouring basins and gating system is rammed-up by hand in green sand.

It requires 170 pounds of iron to pour each block of four cylinders. The finished casting weighs approximately 105 pounds. The production is at present approximately 250 sets per day. The new system has proved eminently satisfactory and evidently is preferable to the green sand method of molding. Foundry losses have been reduced, machine shop rejections have been greatly eliminated and the overall cost has been cut to some extent. In addition, the new method of molding has permitted the introduction of a system of handling the work as a whole that possesses many advantageous features. The drags and cheeks for each day's production are molded on a battery of six turn-over draw machines. One of these machines is shown in Fig. 9. As they come off the machines the finished molds are sprayed with a suitable mold facing wash mixture, after which they are transferred by means of I-beam monorails to the mold drying ovens. When the drying operation is completed, the cheeks are returned direct to the pouring floor by means of a conveyor of the roller type. The drags, however, are first sent to the core assembly department where the jacket cores, combustion chamber cores, manifold cores, port cores, block core, etc., are assembled in their proper positions in the mold. This stage of the work is shown at the right in Fig. 8. The cores are made mostly on machines in the core-room, Fig. 10. The finished cores are delivered from the core room to the storage racks *S*, Fig. 8. The assemblers draw the cores from the store's department as they are needed, the cores being drawn out in complete sets. The assembled drag molds, together with the cheeks, are delivered to the conveyor *C*, Fig. 8. This conveyor transfers the flasks to the pouring floor. The copes are rammed by hand on a bench as shown in Fig. 7. The molds are finally assembled, clamped and prepared for pouring as shown in Fig. 1, a detailed view of a set of pouring gates being shown in Fig. 5.

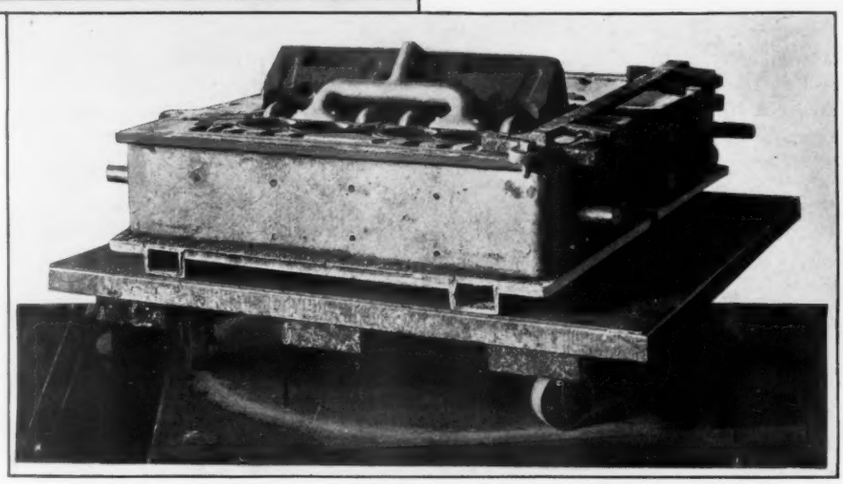

FIG. 3—DRAG MOLD WITH CORES PARTIALLY ASSEMBLED

In their progress through the shop the cheek and drag molds travel around the two sides and bottom of a letter U. The building which is 72 feet in width is divided into four sections. The first section, 128 feet in length, is utilized for molding and pouring, the six molding machines previously mentioned being arranged along the wall on one side. The mold-drying and core-assembling departments are located in a 128-foot section immediately adjoining the molding and pouring section. The

core-making department occupies a 140-foot section at the extreme end of the building. The mold-drying, core storage and assembling department, therefore, are located between the core-making and molding departments. The cheek and drag molds travel, as mentioned previously, to the drying ovens and back again, passing through the assembling department on their way to the pouring floor.

The cores proceed in a straight line from the core room to the core-storage department, which is located alongside the mold assembly benches. From this point the cores follow the drag molds to the pouring floor. Some cores, which are not set until the mold is closed, are transferred directly from the core room to the pouring floor. The molding machine department keeps one day ahead of the core assembling and pouring division, in order to allow sufficient time for all parts of each mold to become thoroughly dry.

The drags are molded on 26 x 8-inch combination jar-ram, turn-over draw machines furnished by the International Molding Machine Co., Chicago. The machines are pneumatic-

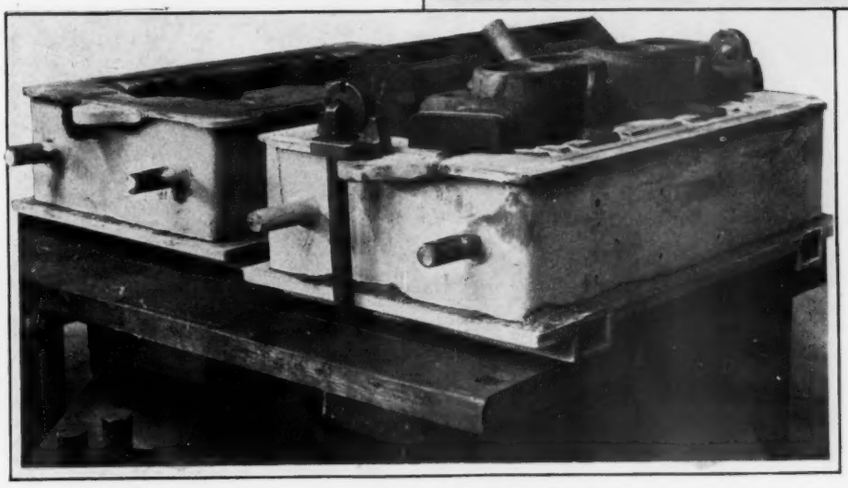

FIG. 4—DRAG MOLD WITH CORES COMPLETELY ASSEMBLED READY FOR TRANSFER TO THE POURING FLOOR—NOTE INGENIOUS CLAMP FOR HOLDING BOTTOM BOARD TO FLASK

ally operated and four are utilized in turning out 300 drag molds per day. Each machine, therefore, is depended upon for a daily output of 75 molds. This is considered a good record in view of the size of the flask and the intricacy of the work. The molding is handled in practically the same manner as for the green sand method described in the May, 1915, issue of *The Foundry*, except that the pattern that was formerly used for the cope now forms the drag, the cylinder being cast head down at present. Before the drags are picked up from the draw tables of the machines they are thoroughly sprayed with the liquid blacking mixture previously mentioned.

Two 26 x 8-inch combination jar-ram, turn-over draw machines, similar to the one illustrated in Fig. 9, are utilized for molding the cheeks. The cheek mold forms the lower part of the cylinder block and the crank case connection flanges. Comparatively little sand is rammed in the cheek, most of this portion of the mold being formed by the dry sand cores. The back of the cheek mold, which is not filled with sand, is temporarily stopped-off during the molding operation by a wood filler-block. Each cheek flask is given about 40 bumps on the jar-ramming table after which the sand is peen rammed and finally butted off by hand. The drag molds also are given about 40 bumps. Three men are employed on each cheek machine. One man handles and blacks the molds while the other two operate the machine.

The method of transferring the molds from the machine floor to the drying ovens is clearly illustrated in Fig. 9. Chains suspended from hand-operated Yale & Towne triplex hoists are utilized to carry the flasks. Two lines of monorail are provided. Before being delivered to the monorail, each cheek is removed from the molding machine and set on the spraying table shown at the right of the illustration, Fig. 9.

One of the drag molds on its way to the drying ovens is shown in the background of this illustration. A small removable clamp *N* is used to hold the bottom-board in place while the mold is being shifted. Another

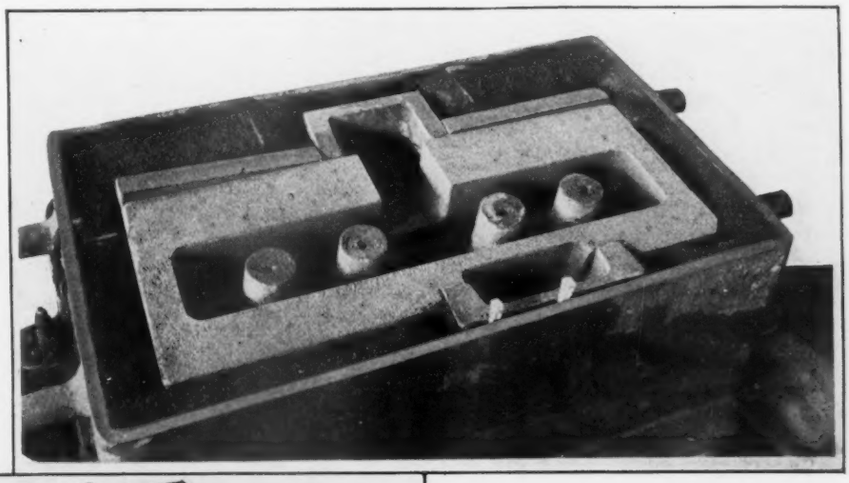

FIG. 5 — TOP VIEW OF ASSEMBLED MOLD SHOWING POURING BASINS AND GATING SYSTEM

view of this clamp, which is of ingenious construction, is shown in Fig. 6 and a still more detailed view in Fig. 4. As indicated by the latter illustration, the clamp consists essentially of three castings. The binding action is secured by rotating the eccentric pivoted to the upper end of the clamping bar. The eccentric is notched at one point to receive the clamping lever or bar. The entire clamp is exceedingly simple and unusually rapid in action.

For drying the molds 11 ovens similar to those shown in Fig. 6 are provided. Three of these ovens are approximately 6 feet wide, 7 feet high and 14 feet deep. The remaining ovens are slightly smaller. They are all fired with coke and operate with a forced draft. The molds are dried for about three hours at a temperature of approximately 400 degrees Fahr. This dries the sand thoroughly to a depth of 2 inches. As shown in Fig. 6, the ovens are provided with cars on which the molds are stacked. About 24 molds are placed on a car. Some of the ovens now used for mold drying formerly were employed as core ovens. To take their place, nine new 7 x 7 x 12-foot car ovens have been provided together with three 7-drawer ovens

for small cores. The work in this department was described fully in the May, 1915, issue of *The Foundry* and has not undergone any radical changes since that time. As formerly the jacket cores are made in three pieces with the main vent passages between the top and middle sections. These passages lead to a ½-inch vent hole in the flask which allows the gas to escape easily.

The jacket cores are fitted and assembled on a mezzanine floor at one end of the core room, a special elevator being provided to deliver the cores to this floor. The assembled units, after inspection, are delivered to the core storage department, *S*, Fig. 8, by means of the gravity conveyor shown at the extreme left in this illustration. This conveyor, together with that used for transferring the molds to the pouring floors was furnished by the Minnesota Mfg. Association, Minneapolis, Minn.

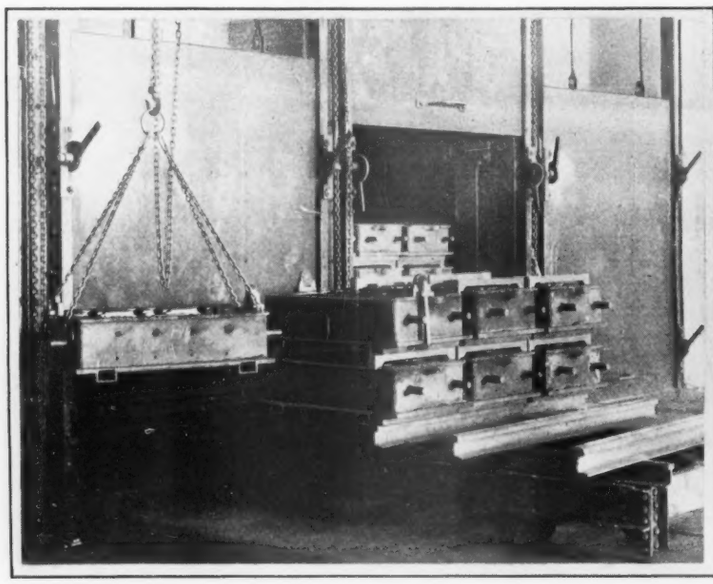

FIG. 6—MOLDS PILED ON OVEN CAR FOR DRYING

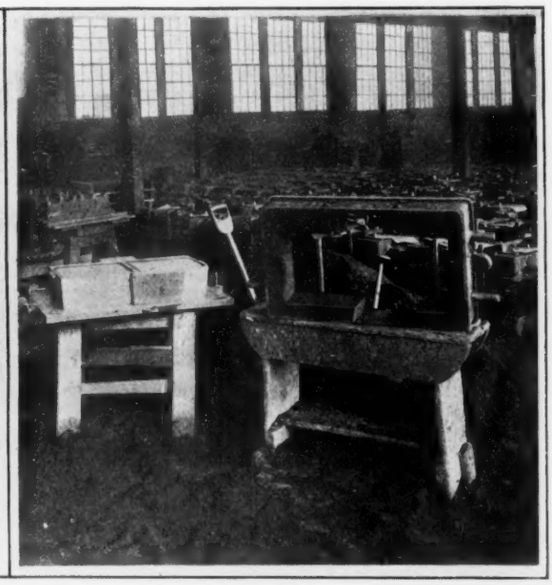

FIG. 7—THE COPE IS MOLDED IN GREEN SAND

Assembling the Cores

Various stages in the core assembling operations are shown in Figs. 2, 3 and 4. As these illustrations indicate, the drag molds are placed in pairs on small tables resting on castors. This arrangement makes it easy to rotate the mold to any position desired by the assembler. When the assembling operations are completed, the flasks are clamped to the bottom board as shown in Fig. 4, using the type of clamp previously described, after which they are shifted, by means of an air hoist manufactured by the Curtis Pneumatic Machinery Co., St. Louis, operating on a crane built by the Brillion Iron Works, Brillion, Wis., to the roller conveyor that extends to the pouring floors. The geenral arrangement of the monorails and of the core assembling department is clearly illustrated in Fig. 8. Owing to the thin sections in the finished castings it is essential that the cores be assembled very accurately and in order to insure correct alignment at important points, gages, similar to the one shown at the left in Fig. 2 and at the right in Fig. 3, are employed.

The assembling operations have been made the subject of motion study and their sequence has been very carefully worked out in order to insure maximum production with a minimum of effort on the part of the operator. Young men of the semi-skilled class are employed for assembling operations. They are remunerated on a flat piece-work basis. The work of assembling the cores in a drag mold, illustrated by Figs. 2, 3 and 4, may be divided into 13 operations which cover everything except a few minor movements. These operations, in their proper order, are as follows:

1.—File vents in dry-sand surface of mold opposite prints *P*, Fig. 2.
2.—Blow out mold with air blast. The mold now appears as shown at the right in Fig. 2.
3.—Set two small plug cores and two chaplets in the bottom of mold.
4.—Set top jacket core, ("top" refers to the top of the cylinder, this core of course being in the bottom of the mold) and gage height of core as shown at left in Fig. 2.
5.—Set four combustion chamber cores.
6.—Paste core prints for port cores.
7.—Set middle jacket core.
8.—Set four port cores.
9.—Set block core supporting manifold core.
10.—Set intake manifold core and gage for position. This stage of the assembly is shown in Fig. 3.
11.—Dry the paste around the block core with blow torch.
12.—Set bottom jacket core and gage for lateral displacement.
13.—Dry all pasted partings with blow torch. The final stage of the assembly is shown in Fig. 4.

An aluminum pattern mounted on an aluminum follow-board is used for ramming-up the copes, as shown in Fig. 7. As previously explained, this portion of the mold is rammed by hand. The pattern and follow-board are shown at the left and a finished cope at the right in Fig. 7.

Mold Assembly Must be Accurate

The molds are assembled and closed by a special gang of men who are skilled in their particular task. Several stages in the assembling operation are illustrated in Fig. 1. The drag molds, as they come off the conveyor, are shown in the foreground and one of the cheeks may be seen standing on edge immediately in front of the drag. A mold with the cheek in place is shown at the extreme right. Finished molds, clamped ready for pouring, may be seen in the middle distance and in the background.

The operations involved in assembling and closing the molds have been worked out as carefully as the core assembly operations, but instead of one man performing the entire job on a single flask, the men work in gangs, each man performing his particular portion of the work. In this manner several flasks are closed up at once. The first operation in closing the mold is to set the center core, which forms the cavity separating the two pairs of cylinders. The main side core forming the side or back of the cylinder block is next set in place. This core is made in two parts, which are pasted together. The pasting operation is performed previous to the delivery of the core to the floor. After these cores are set, the edges of the drag are daubed with

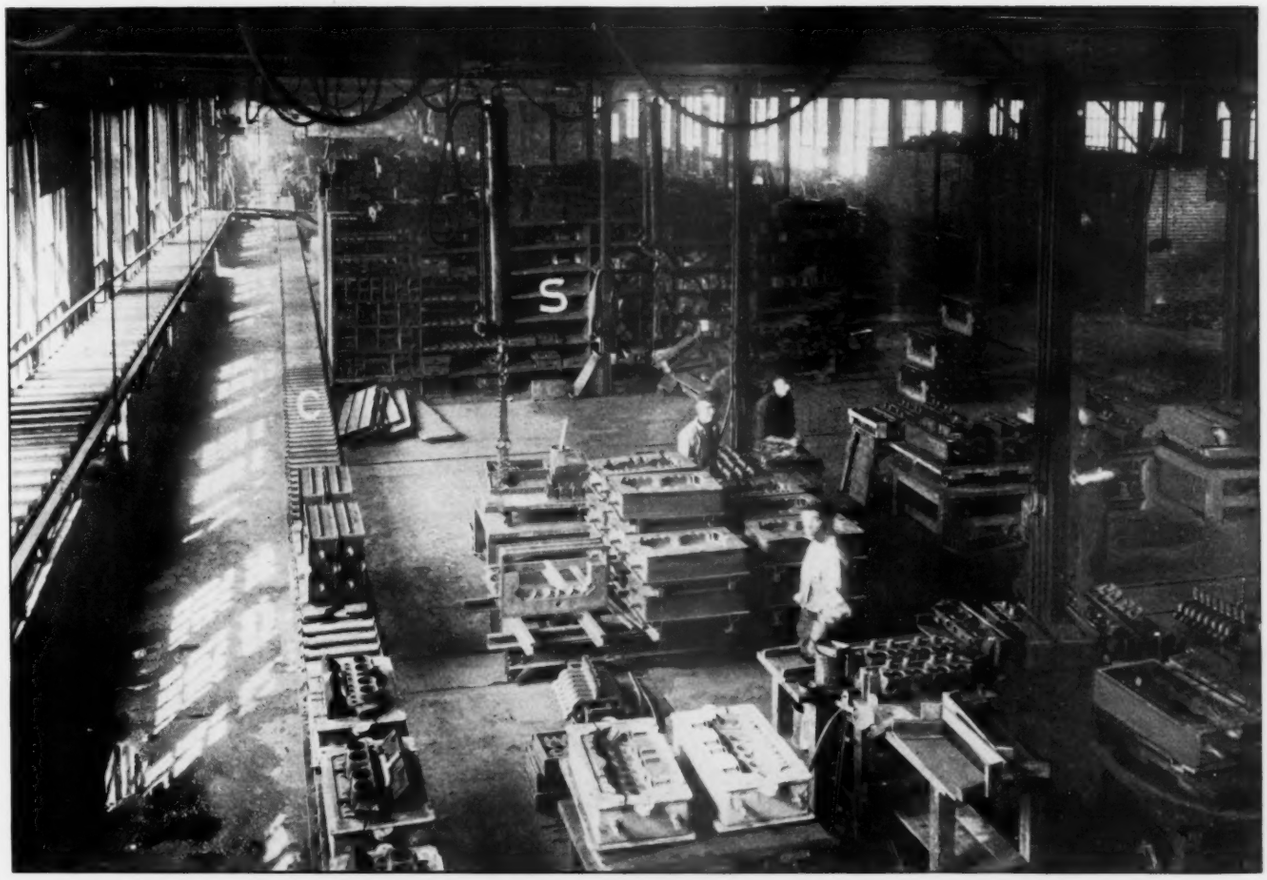

FIG. 8—GENERAL VIEW OF CORE ASSEMBLY DEPARTMENT SHOWING ROLLER CONVEYORS FOR HANDLING CORES AND MOLDS

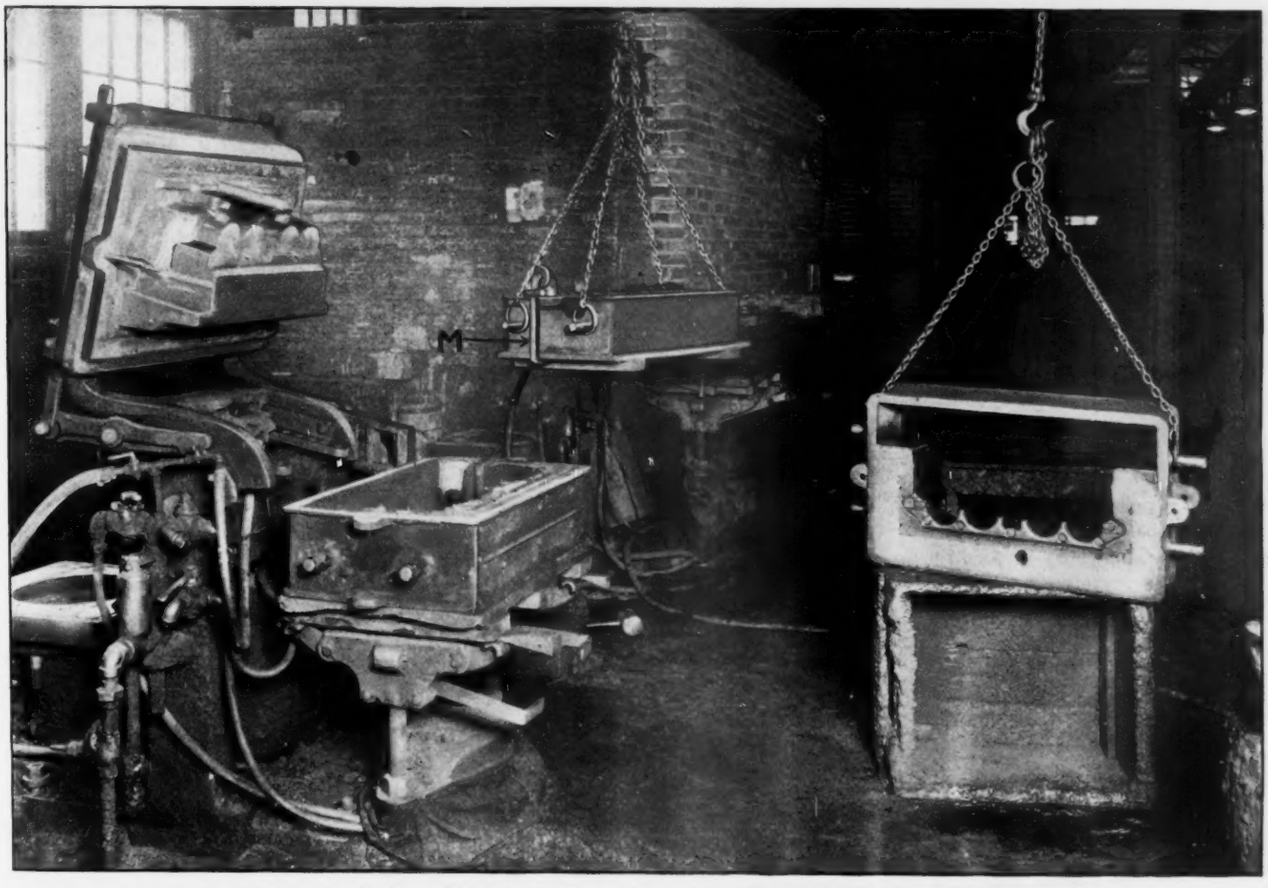

FIG. 9—JAR-RAM TURN-OVER DRAW MACHINE USED FOR MOLDING CHEEKS

paste and the cheek is then set in place. The side core, which fits in the vacant space in the cheek, is shifted to exactly the proper position to give the requisite metal thickness by means of small wooden wedges, which are driven in between the face of the side core and the iron stop-off plate in the cheek. This plate is shown at *L*, Fig. 1. It performs the double function of stopping off the green sand when the cheek is rammed and of forming an accurate surface for the location of the side core. The side core does not fill the entire space left in the back of the cheek and after the core is set and wedged into position this space is filled with green sand, which is lightly rammed in place and struck-off in the usual manner. To prevent the sand from falling into the main part of the mold during this operation a wooden shield is employed. Tissue paper also is laid over the runner holes in the side core to keep out the dirt. After the check is filled and struck off, the four-cylinder barrel cores are set into place and when this operation is completed, the cope is laid on the cheek. Finally, the various dry-san cores forming the pouring basin and gating system are set in the openings provided in the cope. The gating system, with the cylinder barrel cores plainly visible in the center is shown in Fig. 5. The barrel cores project 4 inches through the top cover core. After the mold has been completely assembled and clamped-up, the pouring basins are protected from dirt and refuse by means of heavy strips of brown paper. This paper burns off when the mold is poured.

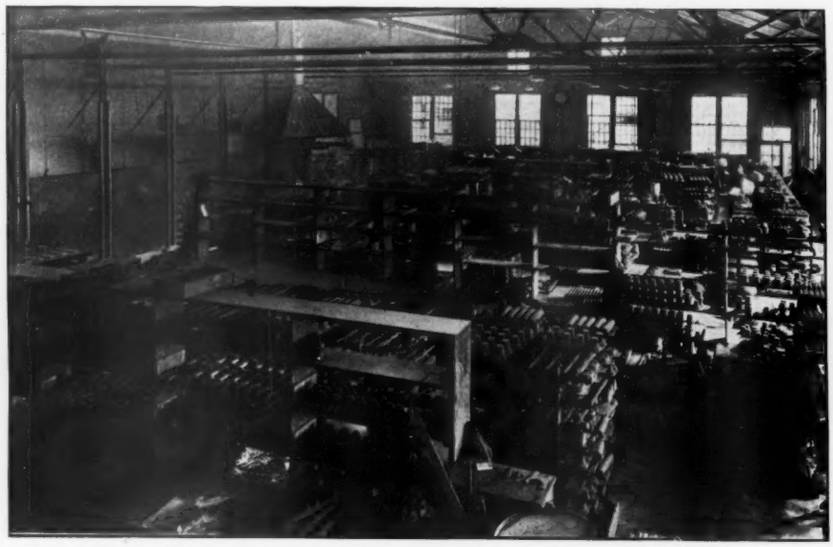

FIG. 10—GENERAL VIEW OF CORE ROOM AT CADILLAC FOUNDRY

The gating system for this job has been worked out with great care inasmuch as the quality of the casting depends to a large extent upon the method of gating. The larger of the two pouring basins, containing the protuberant ends of the barrel cores, is poured first using a hand-ladle containing about 90 pounds of iron. There is a drop gate around each barrel core, in addition to the strainer gate shown at the rear in Fig. 5. Metal therefore enters the mold from this pouring basin through five channels. The strainer gate at the rear leads down through the side core to the bottom part of the mold, which is filled first with hot, fluid iron. After the first ladle is about half emptied a second 90-pound ladle is poured into the small basin shown at the front in Fig. 5. This assists in filling the upper part of the mold. Since two pouring gangs are employed, each mold is poured more rapidly than would otherwise be the case and the temperature of the metal entering the mold is practically uniform. Shrinkage strains are, therefore, evenly distributed. Certain flanges that have shown a tendency to shrink are fed with hot iron by specially arranged lateral runners. As a result of the care taken in gating and pouring the mold, machine shop rejections due to hard spots are virtually a thing of the past at the Cadillac plant.

Will Erect Malleable Plant

A malleable plant to be equipped with two melting furnaces with a capacity of 30 tons per heat, is being built at Kalamazoo, Mich., by the Kalamazoo Malleable Iron Co. The buildings will be of steel, concrete and brick construction. The foundry will be 220 x 265 feet and a covered crane runway for conveying raw materials from the yard to the furnaces will be provided, which will be 80 feet long and 34 feet wide. The coal grinding plant will be 39 x 106 feet. A five-ton electric traveling crane will command the entire length of the foundry, extending throughout the length of the crane room or loading shed. The furnace charges will be made up in this loading shed in bottom dump steel charging boxes, 7 feet long, 22 inches wide and 20 inches deep. The annealing furnaces will be operated with powdered coal as fuel. The coal grinding machinery will be installed by the Raymond Bros. Impact Pulverizer Co., Chicago, and the coal dryer equipment will be furnished by the C. O. Bartlett & Snow Co., Cleveland. The cleaning room equipment, including a sand-blast, will be furnished by the Whiting Foundry Equipment Co., Harvey, Ill. A five-ton hand-operated crane will command the annealing room and a charging machine will be used.

All on Account of Rain

It was a beastly morning. A heavy fog was making life miserable for the river craft and the few pedestrians bold enough to venture out into the streets were glad enough to take refuge in doorways and under lowered awnings when it finally started to rain. It rained with a vengeance. No gentle sizzle-sozzle, but a determined down-pour, better known in that particular locality as a gully-washer. The big open-hearth steel furnace in the plant of Henderson Bros. Co. was pouring a heat when the storm was at its height and the brilliant glow from the molten metal threw a weird light into the faces of the curious passers-by as they stopped and peered into the big foundry.

Now the foundry building where this furnace was located was by no means new. The certain ravages of time, coupled with the acid-bearing fumes from the cupola which was operated for years before the open-hearth had been installed, had played havoc with a none-too-certain roof, and the beating rain was finding entrance. A drop or two seeped through and fell with a splutter and fizz on the roof of the furnace. The superintendent was occupied watching the swift-running metal. Another drop came through, then several and as the rain continued with apparently increasing violence, it was not long until a little steam cloud was appearing on the furnace roof. Then it was noticed, the cause ascertained and immediate orders given for the repair of the roof when the storm was

over. Mike, jack-of-all-trades about the foundry, had other duties when the storm was over, much more important duties to his mind than fixing a roof which was inclined to be slippery, so the appointed task went undone. And then it came pouring time again, and since there was no tell-tale rain, the superintendent forgot to ask whether the roof had been repaired, as per his earlier orders, and the matter was forgotten.

At six p. m. the following day, two hours after the last heat had been taken off, another hard rain pelted that foundry roof. It found the hole once ordered repaired, and proceeded to enter. It dropped straight down on a 1-inch guy rod running the full length of the furnace on the charging side. It dropped and dropped and at seven o'clock that evening that rod snapped and both furnace ends gave way.

The rod had been so hot that the contraction was unusually severe, causing it to give way at its weakest point, namely at a weld about 14 inches from one end of the furnace. Scientists and practical men as well, might have puzzled long and wearily over the problem of what caused that rod to break three hours after the last heat was out. Phrenologists may well puzzle over an equally as queer a problem of a foundry superintendent who, though his furnace had to be closed down for three days for repairs, allowed the hole in the roof to remain a hole for over a week after the accident.

The Use of Borings in Cupola Operations

By James A Murphy

THE melting of iron borings and even steel chips in the cupola for the double purpose of reducing mixture costs and bettering quality is not by any means a new theme for foundrymen to discuss, for in one form or another they have been successfully melted for many years, some methods being more successful and more economical than others.

About 30 years ago a patent was granted to Asa Whitney, of Philadelphia, covering a method of melting borings in wood boxes. This method is in use at the present day by some leading foundries and the results from a quality point of view seem to warrant its continuance. Many other methods are employed, some of which have been subjects of exploitation, and several patents of doubtful value have been granted. A number of the methods indicate an ignorance of the principles involved, while others are freakish, and not a few are most unsatisfactory.

The melting of chips loose in the cupola has been tried both alone and in combination with regular mixtures with very indifferent results. When melted alone the necessary heat will not penetrate the mass, only the under and outer edges of the charge being melted to varying depths depending on the quality of the fuel, the blast pressure and the thickness of the charge. When chips are charged promiscuously with the pig and scrap, the pyrotechnical display at the door and top of the cupola stack indicates the destruction of the elements of which they are composed. It is needless to say that both of these methods have long been abandoned. A few foundrymen, however, lay a thin bed of borings on the cupola bottom. The melting iron coming down on the borings melts and absorbs them, but this in done at the expense of heat that may be badly needed by the iron. I consider this method for either chips or other small particles hazardous in the extreme where particular castings are to be made.

In the middle eighties a foundryman in Scranton, Pa., conceived the idea of filling old powder cans with these borings and charging them into the cupola the same as pig and scrap. The method was said to be very successful and was continued as long as the supply of old cans held out. For years, no substitute except wooden boxes was found.

Discovers Container by Accident

Along about 1904 Stanton Griffith, foundry superintendent of the Fairbanks-Morse Co., Beloit, Wis., was experimenting with the melting of borings in various kinds of containers, none of which were as satisfactory as Mr. Griffith desired. As Newton's discovery of the law of gravitation was accidental, so the method that I am going to describe was accidental to Mr. Griffith through the obstreperousness of a tomato can that found its way into the household furnace where it remained intact for some time, a decided obstacle to good and thorough combustion. Its remarkable state of preservation after going through the fierce fire that is necessary to keep a Beloit home warm and comfortable certainly classed it as an ideal container for melting borings, but as its size was against it a similar but larger can was made from lengths of stovepipe, crimping the can in at each end when full.

These stovepipe lengths will hold about 50 pounds. It is preferable to use either a wood, iron or steel disk for the top or bottom of the cartridge. The containers can be filled at the machines by machinists' helpers at very little if any cost as the borings must be taken away anyway. The cost of preparation for the cupola is about $2.50 per ton.

On three different occasions I melted 10 tons of these canned borings alone, using a blast pressure of from 9 to 10 ounces, our regular blast being from 14 to 16 ounces. All three of these heats showed a loss of less than 2 per cent, which seems remarkable. A 10-ton ladle was weighed on a crane scales and then placed under the cupola spout, and when the contents of the cupola were run into it, it was weighed again with the results above mentioned.

The iron in each case was white and in no way fit for commercial machinery castings. It showed no tendency to stick to the ladle but was hot and fluid. A 6 x 6-inch section poured from the ladle was white all through, not a trace of graphitic carbon being visible near the center. The melting of borings in cans or cartridges is being practised by a large number of foundries engaged in both light and heavy work. There is no patent on the process and anyone is at liberty to use it. It is beyond question a thoroughly successful method.

In 1908 a patent was granted to Walter F. Prince for melting borings in a vertical tube or casing having a higher melting point than the chips. The method at first was open to many serious objections, some of which have since been removed. Borings can be successfully melted by this method, but it lacks what might be called mobility, as all the borings are only in one part of the cupola in a vertical column, with fuel only partly surrounding it, whereas with the cartridges, they can be distributed among the charge, giving a better mixture and insuring more even melting.

The briquetting of borings by the German method, that is, subjecting them in suitable molds to great pressure, is a successful method but the cost is high and there is a considerable melting loss. It is said that the breaking or spalling of the corners and edges of the briquettes represents a great loss. The briquetting of borings through the use of cement, canna pitch or any other wet binder is without question a great failure. The rapid generation of oxygen when moisture comes in contact with the bor-

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A paper presented at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916. The author is foundry superintendent, the Hooven, Owens & Rentschler Co., Hamilton, O.

ings soon leaves only a lump of rust to put in the cupola and when used in this way is productive of bad castings, as pin holes and blow holes are prevalent. The melting loss by this method was found by experiment to reach as high as 60 per cent, while the resultant metal was bad. Castings poured with it for experimental purposes were very unsound and literally honeycombed with holes, while on the other hand castings poured from similar metal, taken from a ladle that was filled from the cartridges was sound all the way through and showed no signs of pin holes or any other unsoundness.

As a practical proposition the use of borings in binder bound briquettes is a failure in almost every case. The briquettes made under enormous pressure are satisfactory, but the cost and melting loss is much higher than when melted in cans or cartridges. The tube method introduced by Mr. Prince has very narrow limitations as to the amount used, this being governed by the size of the tube which of necessity must be comparatively small. If a multiplicity of tubes is used, I think there is great danger of oxidation, as no fuel is distributed underneath them. They can only be placed in one position in the cupola which must be specially prepared for the tubes with a special door cut in the side. The attendant labor and waste of filling close to terrific heat is another objection.

With the cans or cartridges no extra labor is involved on the charging floor and the given amount to be put on any charge can be as evenly distributed throughout the charge as any component part of it. The cost of canning the borings exclusive of the labor of filling them is about $2.50 per ton. The filling labor should hardly be counted under most circumstances as the borings must be taken away from the machines and the helper may as well fill the cans as to use any other receptacles. Borings melted by this method are a decided strengthener of castings and tend to give a closer grain. They have been used in various percentages in all kinds of work from the heaviest parts of high class machinery down to light automobile castings with unvarying beneficial results. The cost of wooden boxes is also about $2.50 per ton and the cost of tubes very little less.

Sanitation and Shop Hygiene for the Foundry

By J F Alexander

SANITATION or hygiene is the art of preserving health. It is its province to seek out and determine the causes of disease, and to formulate rules for their prevention and removal.

In the work of accident prevention, which is making great progress in Canada, it appears that so far sufficient attention has not been given to shop hygiene, to lighting, sanitation, ventilation, etc. Inadequate lighting is as conducive to accidents as unguarded machinery. Natural light could be greatly improved by greater efforts being made to keep all windows clean. Where natural light is difficult to get, then an abundant supply of artificial light should be supplied and arranged in such a way as to give the maximum light to the workmen, at the same time protecting them from glare. Insufficient lighting is responsible, partly, for many machinery accidents, and is almost wholly responsible for such accidents as falls from ladders, stumbling over projections, and tripping on stairs.

Air is the prime necessity of life. Food or water may be abstained from for a considerable period, and we may thus replace either should we doubt its purity or wholesomeness, but the atmosphere around us we must breathe or die, hence the paramount necessity of having it pure. But, although this is so obvious, attention to its importance is often neglected. Diseases which are known to arise from the effects of vitiated air are well known and need not be mentioned in connection with this subject. The air of all foundries is more or less mixed with fumes arising from molten metals which contain zinc, smoke from core ovens or from large molds containing cores, and dust. Practical remedies are known for all these conditions, and it should be the duty of every one operating a foundry to see that they are adopted. It is far better to eliminate the cause than to try to correct the result. Smoke can be eliminated to a great extent by improving the combustion of fuel and using smokeless core binders. Dust conditions can be greatly improved by the use of brick, concrete, or wood block floors, and by frequent sprinkling. Where it is found impossible, owing to the nature of the work, entirely to eliminate dust and fumes, respirators should be provided.

Good Ventilation is Needed

On account of economy, natural ventilation is most frequently employed and is found to be satisfactory in many cases. Where this method is not sufficient it should be supplemented by a well-designed mechanical ventilating system, of which there are various highly efficient designs on the market.

Clothing should fulfil the functions of preserving warmth in cold weather and providing covering without being oppressive in hot weather—it should admit of frequent change and cleansing. Foundry workers are often in a state of profuse perspiration, and for this reason they should be urged to provide themselves with two changes of clothing and the working suit left in the locker at night to be dry and warm for the next morning.

Well-ventilated lockers should be provided for workmen to hang their clothes in, and steam coils should be placed under lockers in order that the clothing shall be thoroughly dried.

Too much stress cannot be laid on personal cleanliness. Filth is one of the prime factors in the production and propagation of most of the devastating plagues known to mankind. Ample bathing facilities should be provided in all foundries, and it should be insisted on that the men take advantage of these facilities. An adequate number of wash basins should also be provided and they should be kept clean and free from obstructions at all times.

The soil or site on which a plant is located is a most important factor in preserving health. Much that has been attributed to climate has often been due to locality, but unfortunately the most healthful locations are not always available for industrial plants.

Cleansing, including the removal of refuse, excreta, etc., forms one of the most important, and, at times, the most difficult of questions. The main principle is that all should be immediately and effectually removed from the buildings and their neighborhood, and that there should be no possibility of a reflux of foul air from drains, etc. The system of water carriage should be adopted, and the earth system and other dry methods avoided wherever possible.

A sufficient number of wash-out, self-flushing closets should be provided in all foundries and toilet-rooms should be kept clean at all times.

The securing of an adequate supply of good water merits special consideration, so important is its relation to health, both directly as a drink and indirectly with reference to its many other uses. It is required for drinking,

A paper presented at the fifth annual safety congress of the National Safety Council, Detroit, October 17-20. The author is secretary, the Metal Trades Safety Association, Toronto, Can.

the cleansing of a person and clothes and for flushing of closets,, sewers, drains, etc. The hygienic requirements are that water should be good in quality and sufficient in quantity. Good water should be clear, colorless, quite free from suspended matter, of a good lustre, and should have a pleasant sparking taste. In its chemical composition it should be as free as possible from organic matter.

The evidence in favor of communication of disease by means of drinking water is very extensive, and many diseases such as diarrhoea, dysentery, ague, enteric fever, and many others may be cited as being conveyed through this channel. Numerous parasites also find their way into the human body by this means.

Drinking fountains should be provided in sufficient numbers in all works, where pure cool water is available for workmen at all times, and the common drinking cup should be abolished.

The custom adopted by some of the larger firms, of having all applicants submitted to a physical examination prior to engagement, cannot be too highly commended, and the practice should be widely extended. A system of thorough physical examinations will result in the elimination of the "booze fighter." In this connection it is the belief of the speaker that this will do more for the temperance cause than legislation, for when a man finds that he cannot secure employment he will pull himself together if there is a spark of manhood left in him. Moreover, men who are defective will not be assigned to work for which they are unfitted, and fewer contagious diseases will be introduced into the works.

First Aid

The advantage of first aid treatment as a means of preserving health and life cannot be too highly emphasized.

During the year 1915 in Ontario 10 per cent of the cases dealt with by the workmen's compensation board were infectious. Practically all infections can be prevented if treated in time, therefore it is of the utmost importance that every foundry be provided with a first aid equipment, and that some person be instructed in its use. This applies of course to smaller places where a surgeon is not in attendance.

A 40-page booklet entitled "A Model Foundry" has been issued by the Whiting Foundry Equipment Co., Harvey, Ill., which, in a general way describes the methods followed by this company in designing, equipping and conducting the initial operation of complete foundry plants for the manufacture of gray iron, brass, car wheels, pipe, converter steel and malleable castings. The plans for a model combination gray iron and steel foundry having a capacity of 30 tons daily are included, as well as the list of the equipment, and illustrations of such a plant are shown, the machinery largely being illustrated. Typical crane installations also are shown and views of car wheel foundries equipped by the Whiting Foundry Co. are included. A list of some of the notable casting plants in the United States and Canada, equipped by this company, also is given.

Mixture for a 22-Ton Slag Ladle

By G. S. Evans

Question:—In casting a 22-ton slag ladle we propose to use 10 tons from an open-hearth mixer containing silicon, 1.25 per cent; sulphur, 0.03 per cent; phosphorus, 1.55 per cent and manganese, 0.40 per cent. In addition, we will use 12 tons from a cupola melting an average of four tons per hour, the iron from which will analyze silicon, 1.20 per cent; sulphur, 0.039 per cent; phosphorus, 0.161 per cent and manganese, 0.51 per cent. Would it improve the casting to add approximately 2,000 pounds of melted steel to the iron from the mixer? Also let us know whether the addition of ferro-manganese or ferro-titanium is necessary. Would the addition of steel have a tendency to make the iron freeze more quickly in the ladle than if no steel were added?

Answer:—Assuming that the total carbon content of your metal is 3.35 per cent and with the two mixtures quoted, the analysis of the resulting casting would be as follows: Silicon, 1.22 per cent; sulphur, 0.035 per cent; phosphorus, 1.58 per cent and manganese, 0.48 per cent. The addition of 2,000 pounds of molten steel, namely soft open-hearth material, would give the following analysis: Silicon, 1.17 per cent; sulphur, 0.035 per cent; phosphorus, 1.52 per cent; manganese, 0.46 per cent and total carbon, 3.21 per cent. The latter mixture is the better of the two. However, both are too high in phosphorus and too low in manganese for a casting of this size and regardless of how much care would be exercised in molding, shrink holes would develop.

A better mixture would consist of 8 tons of the open-hearth mixture, 8 tons of cupola metal and 6 tons of open-hearth steel. This would give you a casting having approximately the following analysis: Silicon, 0.90 per cent; sulphur, 0.033 per cent; phosphorus, 1.16 per cent; manganese, 1 per cent and total carbon, 2.70 per cent. The extra manganese required to bring this element up to 1 per cent in the casting would be 460 pounds of ferro-manganese if added in the ladle or 575 pounds if melted through the cupola. This amount of alloy can be added to the molten steel without materially reducing its fluidity. However, I suggest passing this alloy through the cupola by distributing it throughout the charges that make up the cupola mixture. The addition of steel to cast iron, whether made in the molten state in the ladle or melted through the cupola, raises the temperature at which solidification begins, that is, it shortens the setting time or tends toward quicker freezing of the metal in the ladle. With this volume of metal, however, you should experience no trouble from freezing to the ladle, provided the latter is well heated before the metal is added. By keeping the surface of the metal covered with charcoal or coke dust the latter mixture could be held in the ladle for several hours without difficulty. While this mixture is still much higher in phosphorus than it should be, nevertheless it will produce a good casting and one that will be well adapted to withstand high temperatures and sudden temperature changes. The feeders for the mold of this casting should be made about one-third larger than ordinarily is used for gray iron mixtures.

Cupola Daubing

By W. J. Keep

Question:—What material generally is used for daubing or patching the melting zone of cupolas. We have been using sharp sand mixed with fire clay to one-half of its bulk, but this does not give satisfactory results.

Answer:—A good mixture for patching the cupola can be made from one part of sharp sand and two parts of fire clay, which should be reduced to the consistency of paste with water. Fire sand also can be used for this purpose. This daubing mixture should not be employed to fill up holes or to hold pieces of brick in these holes. When the melting zone is cut away considerably, carefully cut out one or more bricks far enough into the lining to permit of keying pieces of brick in place. The daubing mixture should be used to smooth the surface only and to hold pieces of brick where they will not fall off. If the daubing is applied too thick, the surface next to the fire will shrink, causing it to curl and fall off.

Burt B. Brewster, for several years manager of the Alaska office of the Sullivan Machinery Co., Chicago, with headquarters at Juneau, has been transferred to Salt Lake City to become manager of that company's branch office, succeeding H. E. Moon, resigned.

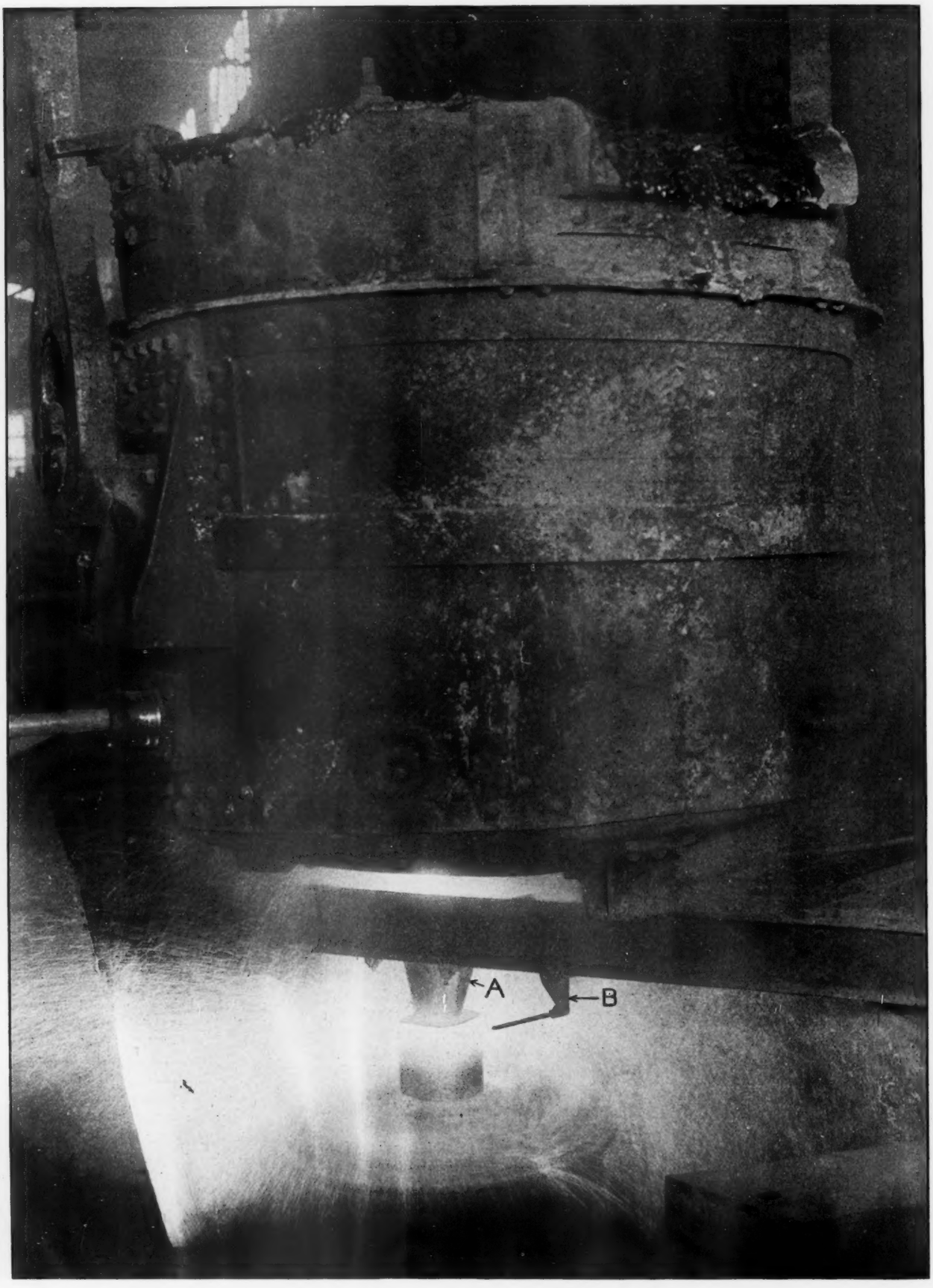


FIG. 1—CASTING A CAR WHEEL WHICH HAS A HIGH MANGANESE TREAD AND FLANGE AND A DUCTILE PLATE AND HUB

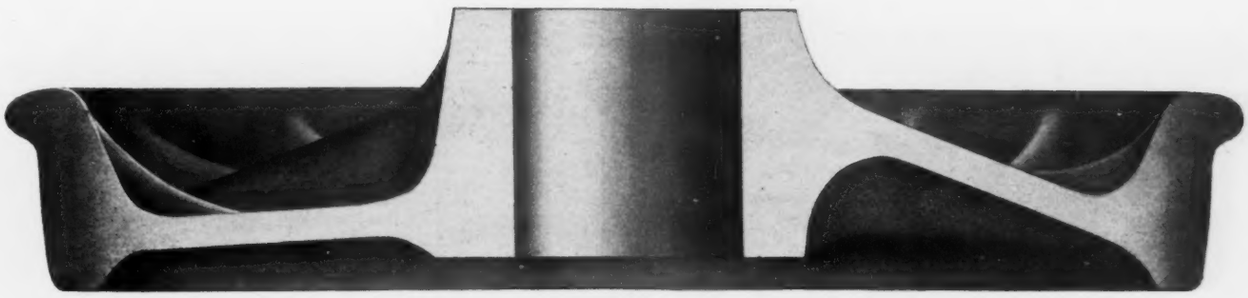


Fig. 2—Cross-Section of Wheel

Casting Car Wheels With Manganese Treads

Wheels Having Hard and Tough Treads and Flanges and Ductile Plates and Hubs Are Cast in Revolving Molds Into Which Ferro-Manganese is Introduced

THE vigorous development of American industry in the past decade and a half has forced manufacturers to consider carefully all plans for revising shop practice, however chimerical they may seem at the outset. The production of many shops has been doubled and even trebled, quality improved, wages increased and costs reduced through the hardihood of some executives in experimenting with ideas that 20 years ago would not have received a hearing, let alone a trial. For instance, the science of bricklaying is the development of thousands of years, yet a few years ago careful study and analysis evolved refinements in this ancient art that practically doubled the productive capacity of each workman.

While still in its swaddling clothes, comparatively, foundry practice in its major essentials is apparently firmly circumscribed. Refinements in molding and cleaning room practice are being steadily made through the introduction of machinery but pouring practice has undergone little change in principle since the first castings were made.

Peculiar interest, therefore, is attached to the methods recently developed at the Granite City, Ill., plant of the American Steel Foundries for pouring car wheels. The engineers of this plant some years ago began a study of the problem of casting a car wheel which would have a hard, tough, manganese steel tread and flange, and a ductile steel plate and hub. The success of these efforts is evidenced by the service which car wheels of this kind are now performing.

The main features of this radical departure from accepted practice consist of revolving the mold and at the same time introducing powdered ferro-manganese into the molten metal first entering the mold. This high manganese steel is forced to the periphery by centrifugal action, the stream of ferro-manganese being then cut off and the center of the wheel cast of untreated steel.

This method of pouring is clearly

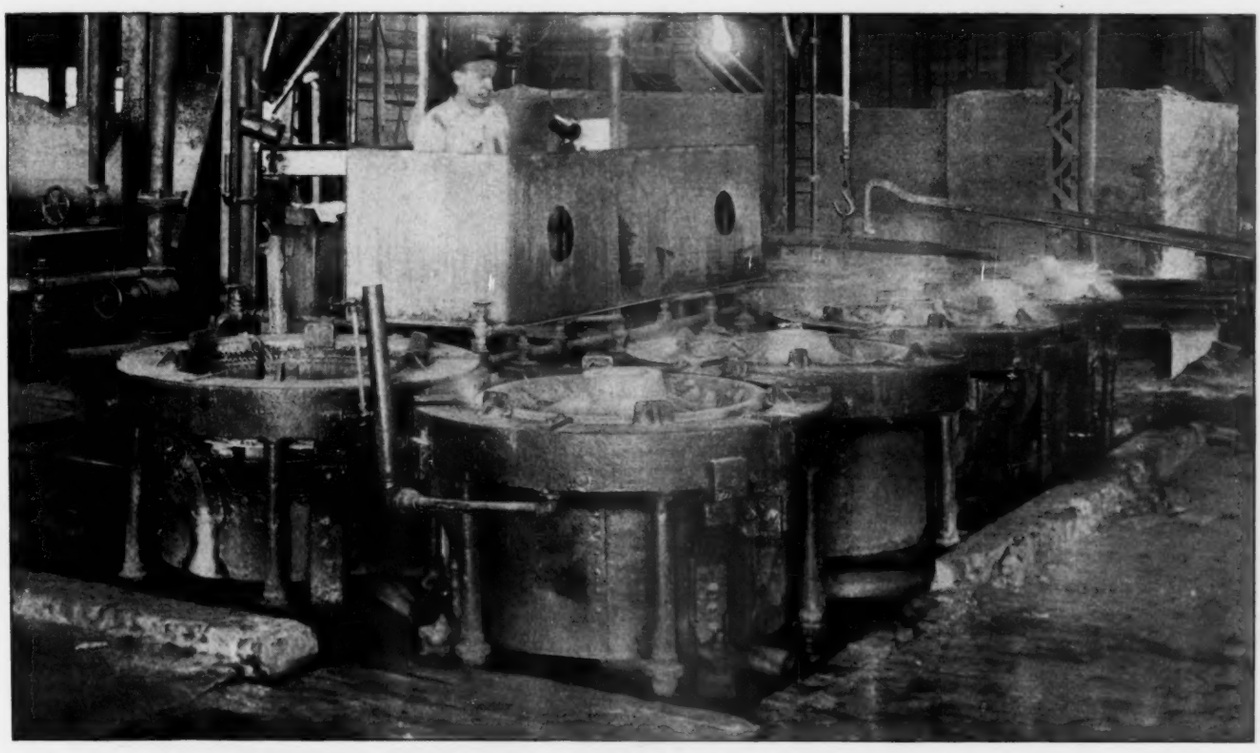
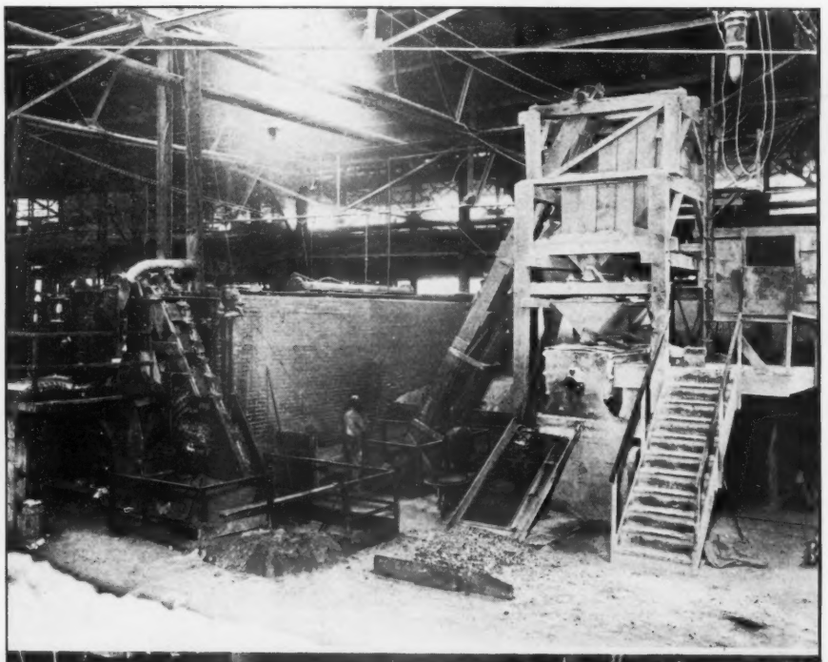
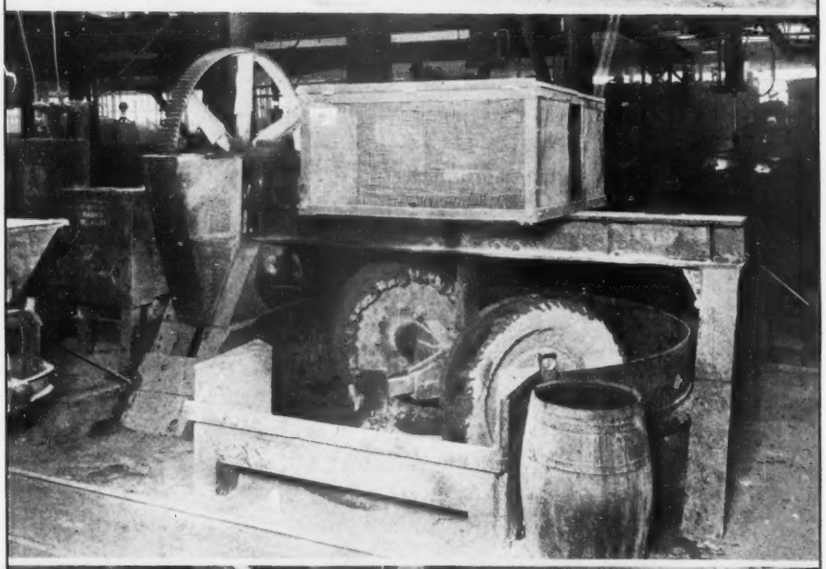


FIG. 3—AN ANNEALING DEVICE—THE TREADS ARE SPRAYED WITH WATER TO INCREASE WEARING QUALITIES





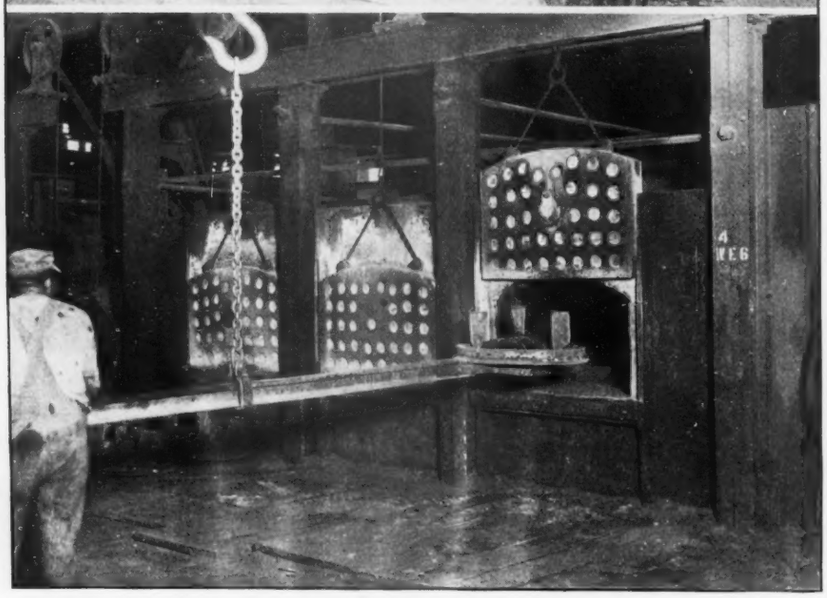


FIG. 4—DRYER, WEIGHING AND SAND MIXING EQUIPMENT
FIG. 5—PREPARING SAND IN A SAND MILL
FIG. 6—WHEEL ENTERING ANNEALING OVEN, SHOWING ARRANGEMENT OF GATE AND RISERS

revealed in Fig. 1. The steel on leaving the ladle passes through the intermediate sand cup shown at *A*. This cup is designed to correct irregularities in flow that might arise from a worn nozzle on the ladle. The ferro-manganese is blown into the stream of steel through the tube *B*. The mixture, or high manganese steel, then enters the mold, which revolves on a table in the casting pit.

Before the process was perfected various details presented themselves as separate problems, each of which had to be solved singly. It was necessary to establish the relation between the length of time occupied in introducing the ferro-manganese and the total time required in pouring the wheel; to obtain uniformity in the rate of pour, and to determine the rate of rotation of the table carrying the mold. Each of these factors was found to be of relatively large importance in insuring a successful outcome and variation in any one brought undesired results.

Departures from ordinary foundry practice begin with the preparation of the sand and continue through the molding operation, varying markedly at many points from usual methods.

One of the essential elements in all operations from the time of making the mold until the wheel is allowed to cool after the flange and tread have been tampered, is proper timing to insure uniformity of result. This has been carefully tested until a standard practice has been developed.

Particular care is bestowed on the preparation of the sand. Only new sand is used for facing. It is necessary that the face of the mold be smooth and homogeneous, and at the same time capable of being hardened to withstand high heat and unusual washing tendencies of the molten steel without becoming brittle. The sand-handling plant is shown in Fig. 4, the dryer being shown at the left. The sand passes through a grating into a pit from which it is elevated to the dryer. Another elevator conveys it to the screens, shown at the right, where all lumps are removed. It then passes to the weighing machine which operates automatically. At this point the bonding material is added. The sand is then dumped into cars on a depressed track and taken to the sand mill, Fig. 5, where the rolls and plows transform it to a plastic uniform mass.

The facing mixture is hand rammed against the pattern, which is mounted on a roll-over plate. The backing sand is then filled in and the mold placed on the jarring machine shown in the foreground in Fig. 8. The time of ramming is definitely prescribed. In the background in Fig. 8 the hand ramming of the facing

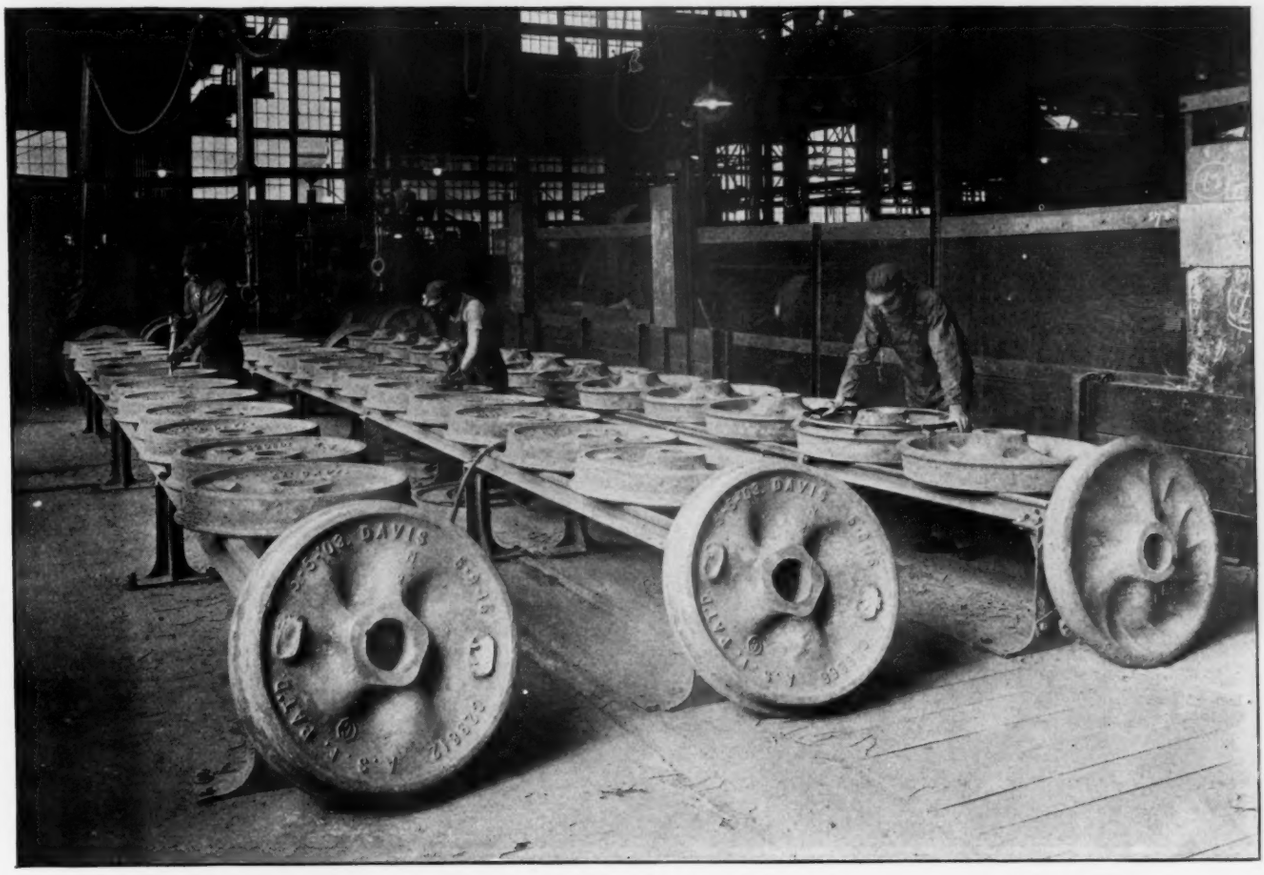


FIG. 7—CHIPPING AND INSPECTING THE WHEELS—STUBS LEFT BY RISERS AID INSPECTION

sand is illustrated. Cope and drags made at the same time are numbered alike. The successive pairs are numbered in rotation so that proper pairs will be matched when cast.

Unusual care is exercised in preparing the mold as it is subjected to unusual strains when cast, the steel being carried outward from the gate at great speed by centrifugal action. The sand surface, therefore, must be unusually hard and smooth.

FIG. 8—JOLT-RAMMING BACKING SAND AND HAND-RAMMING FACING SAND

A finish resembling the surface of stove plate is obtained in the sand.

The cope and drag are transferred by pneumatic hoist and monorail to the position shown in Fig. 9, where they are slicked, repaired, if necessary, and then skin dried. The hub core, which contains the gate, is then placed in position. The hard and smooth surface of the sand is clearly shown in this illustration.

The web of the wheel is not of uniform flat section, but consists of five eccentric radial waves which act as strengthening members. These are curved in the direction taken by the steel in reaching the circumference much like the vanes of a centrifugal pump. Their shape hastens the movement of the metal and lowers the resistance of the mold surface consequently reducing the strain to which the mold is subjected. These radiating curves are well indicated in Fig. 9.

After the cope and drag are assembled, the completed mold is carried to the storage floor. A cross chain, midway of the loop by which the crane lifts the molds, permits two molds to be carried at one trip and doubles the capacity of the crane.

In the actual casting of the wheel the most marked departure from ordinary methods is found. Although the entire mold is poured in a continuous operation, the first steel, as previously outlined, goes to the tread and flange after being alloyed with manganese, while the remainder, which forms the web and hub, is not alloyed as it is poured in the mold. The mold is placed on a table in a casting pit. Several pits are provided, each containing two tables. These tables are rotated by electric

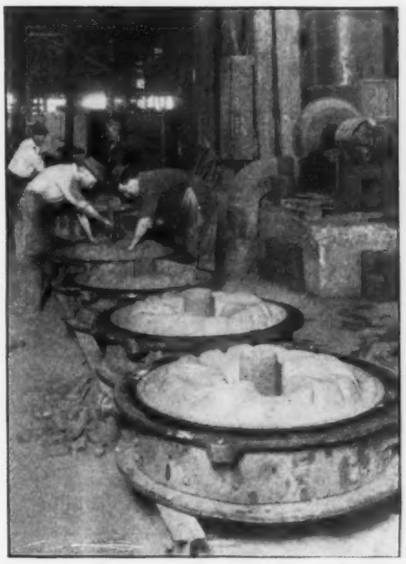


FIG. 9 — SLICKING THE MOLD AND PLACING CORE FOR HUB—CORRECT SKIN DRYING IS AN IMPORTANT FACTOR

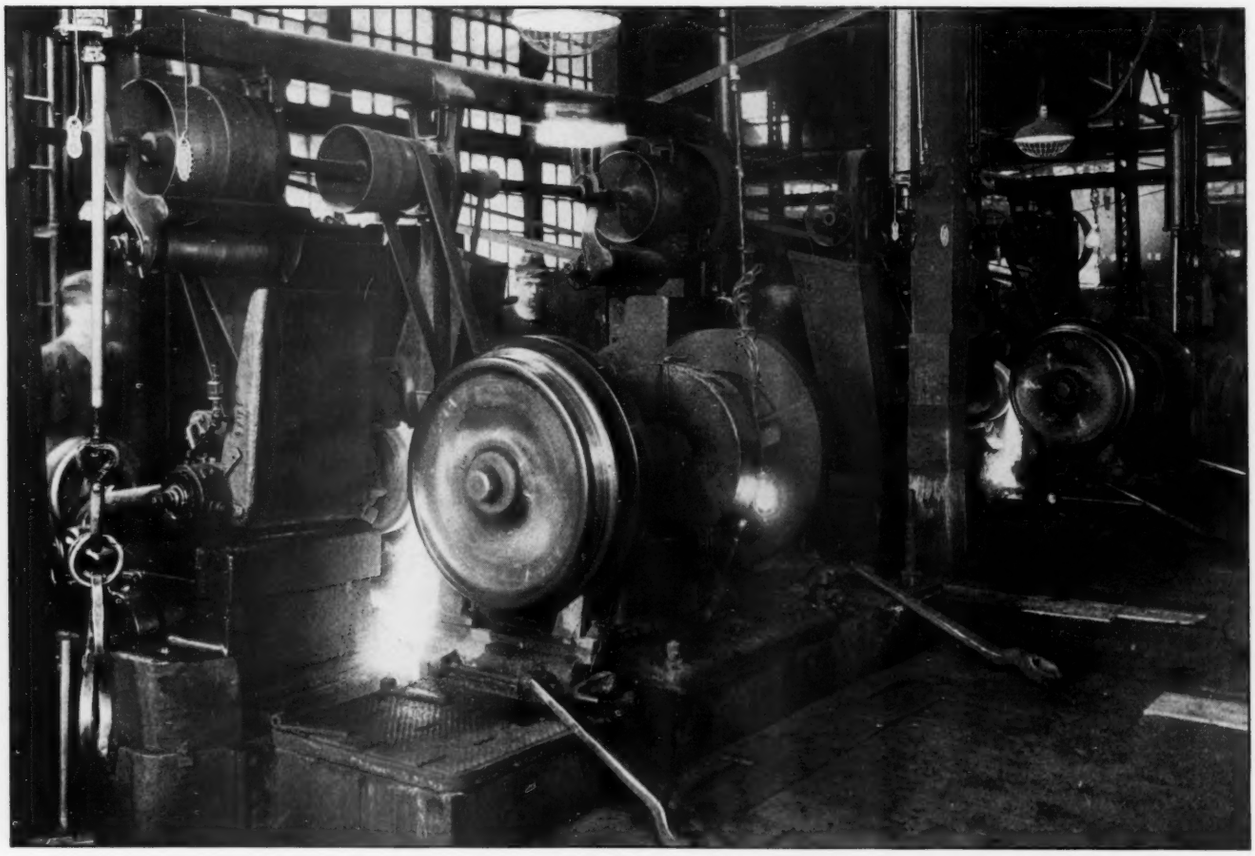


FIG. 10—GRINDING TREAD TO INSURE A CORRECT CONTOUR—A PAIR OF WHEELS IS MOUNTED ON ONE GRINDER

motors at speeds determined by careful tests. As the ladle of open-hearth steel is carried over the pit, the mold is started rotating at the proper initial speed and the operator begins pouring in the usual manner. Instead of passing directly into the mold, the steel first enters the intermediate sand cup, *A*, Fig. 1, which is supported on a framework just above the gate. Unequal wear of the ladle nozzle frequently causes the stream of steel to mushroom or take some irregular shape. As it is essential in this process that the pour be uniform in volume and speed, the intermediate cup is introduced to correct inequalities of this sort. When its internal surface is burned the cup is easily replaced.

Carried on the framework bearing the intermediate cup is a tube terminating close to the stream of hot metal, as plainly shown at *B*, Fig. 1. The ferro-manganese is blown through this tube into the descending steel and is thoroughly mixed before the mold is reached. The quantity of manganese and the time occupied in its introduction vary with each type of wheel, in proportion to each particular weight and section.

In addition to carrying the manganese treated steel to the periphery of the mold, the centrifugal motion also has a positive action in filling the risers. Two large risers are provided, sufficient to balance the weight of the wheel and take care of all shrinkage which may take place.

After being shaken out the wheel is placed in a Hagan stoker-fired annealing oven using Illinois washed coal. The temperature is uniformly maintained, being recorded by a Bristol indicating and recording pyrometer. After annealing, the risers are sledged off and the gate is removed under a punch. The shape of the riser is designed to give a notch at the junction of riser and wheel and a heat crack is developed which facilitates removal, a few blows of the sledge sufficing and leaving a surface requiring only slight grinding.

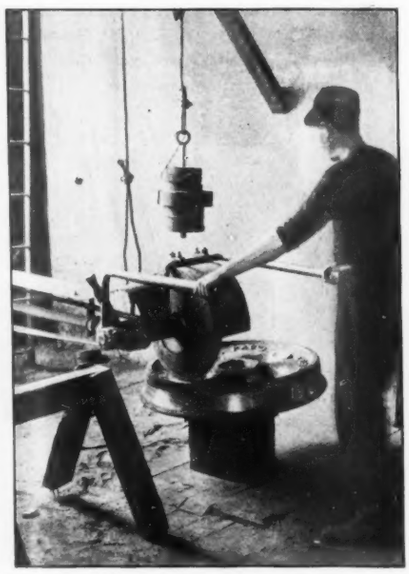


FIG. 11 — REMOVING RISER STUBS WITH A SWING GRINDER

The castings are then shot blasted, chipped and inspected and the riser stubs ground down. The wheels are then placed in a grinder and the tread ground to the proper contour, and any irregularity of rotundity corrected, after which the hubs are bored out.

The tread is tempered by reheating the wheels in a furnace exactly like that used for annealing, after which they are placed in a tempering machine where water is sprayed on the tread and flange, as shown in Fig. 3. The heat of the casting is determined by a Fery radiation pyrometer, the operator starting the flow of water when the temperature is at the proper point and shutting off the water at another prescribed level. Before shipping, each wheel undergoes a drop test, in which it is placed on three points of support and subjected to two blows of a 500-pound weight dropped 6.5 feet. Final inspection, measurment of the circumference and the hardness test by means of a scleroscope complete the process.

The Designing Engineer and the Steel Foundry

Better Co-operation Between the Men Who Design Castings and Those Who Mold Them is Needed—The Engineer Must Not Demand Impossible Castings

By John Howe Hall

PROBABLY the best way to point out the desirability of co-operation between the designing engineer and the maker of steel castings is to give from the foundryman's point of view some of the difficulties encountered in endeavoring to execute contracts for engineers who are not sufficiently acquainted with foundry practice to design and specify castings correctly, and who have not learned the desirability of personal contact with the foundryman who is to make the casting.

Foundrymen Meet Difficulties

I think most foundrymen will agree with me in saying that their difficulties in this line may be classified under two headings: Difficulties with physical and chemical specifications and difficulties in trying to make castings of a design not suited for steel foundry work.

Specifications that have come to the notice of the author, that cannot well be executed, can be divided into several general classes. The first of these, is that specification which includes unusual chemical or physical tests. Thus at times the specification says that the steel must contain not over a very small amount of phosphorus or sulphur and that amount so small that it can be secured only with steel of the very highest grade made in the electric furnace or in crucibles. In many cases it is found upon investigation that the price which is to be paid is not sufficiently high to warrant the use of vary pure material in crucibles to meet the chemical requirements, or to warrant the use of electric furnace steel. It will frequently also be found, under these circumstances, that the castings do not need to be particularly strong nor tough, and when the engineer drawing the specification is open to conviction, a compromise is often reached by which the regular steel turned out in the shop is used to execute the order with perfect satisfaction to all concerned.

Again, specifications come in which call for a manganese content not over a figure which is now known to be quite low for good steel. Frequently the men who are bidding on the order are in the habit of using a great deal more manganese than the specifications allow, and know, from long experience and extended tests on their steel, that the high manganese steel they make is more satisfactory than steel made in accordance with the specifications in question. A little conversation between the specifying engineer and the foundryman generally clears up this difficulty, and the foundry is allowed to use its regular grade of steel. This difficulty with manganese specifications probably arises from the opinion generally held 20 years ago that manganese over 1 per cent, or even a little lower, caused brittleness in steel. More recent researches, of course, have shown that under proper conditions a good deal more than 1 per cent manganese can be used in steel not only with perfect safety but with great advantage.

At the present time, owing to the high price and scarcity of ferro-manganese, the foundryman in many cases is anxious to use not more, but less, manganese, than the specifications call for. In a great many cases his engineers have made extended tests of their steel and found that by the use of special alloys or special procedure they are able to make perfectly satisfactory steel with less manganese than the specification calls for. In these cases, if the steel can be shown by tests to be perfectly satisfactory for the service desired, it is manifestly unfair to compel the unfortunate steelmaker to use more manganese than he has found necessary.

Chemical Specifications

Another case in which the chemical specifications become a stumbling block, is when alloy steel is specified and the foundryman is quite sure that a good grade of ordinary carbon steel is best for the purpose. It should be said in all fairness that this class of specification is rather rare, and that in most cases it is accomplished by a failure to specify the amount of the alloy in question that is desired in the steel. Thus specifications are received calling for chrome steel, or nickel steel, or vanadium steel, with the amount of the alloy not specified. In some cases these orders are finally executed in a good grade of ordinary steel; in others the correct amount of the alloy to best suit the conditions is used by the foundryman; and in still others the order is turned down because it is not worth the foundryman's while to go to the trouble and expense of using the alloy in question for an order which does not amount to a great deal in total value.

Impossible Elastic Limits

Another troublesome specification, which is probably more often met by makers of special steels for abrasive wear than by the ordinary foundryman, is the specification calling for a very high elastic limit in the steel. In some cases this elastic limit is higher than it is possible to reach with a steel casting; and in other cases, the equally troublesome fact is found that the elastic limit specified is so high that the steel is not machinable and considerable machining has to be done on the casting. Where the machining is done in the foundryman's shop, it is, of course, possible sometimes to rough machine the casting, then heat treat for the desired physical properties and then grind to shape. There are, of course, a certain number of cases where this procedure is necessary because the steel must have the physical properties called for. But in the experience of the author, there are a number of cases in which the very high elastic limit is called for by the designing engineer with the expectation that the steel can be machined after heat treatment. Under these circumstances, of course, unless the engineer and the foundryman get together personally or by letter and have a heart-to-heart talk, some one's feelings are going to be hurt when the order is delivered.

In a certain number of cases, an elastic limit is specified which cannot be secured without special heat treatment of the steel, and the design of the casting is such that it is impossible to heat treat it without cracking it. Such cases, of course, can be taken care of either by modifying the elastic limit called for, or by so modifying the design of the casting as to eliminate the danger of cracking it in the heat treatment. The author is familiar

Excerpt from a symposium presented at the annual convention of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916.

with a great many cases where this difficulty has arisen, and has seen it taken care of, sometimes by one method, sometimes by the other.

Still another class of specification which has come to the author's attention, is that in which an alloy steel of one kind is specified for a class of service in which, according to the experience of the foundry executing the order, an entirely different alloy steel will give very much better results. This, in some cases, may be an instance where the foundry could learn from the engineer, as well as the engineer from the foundry. Thus if the engineer is specifying the particular alloy steel that he does specify in the belief that it will be good for the class of service in question, but without definite experience to prove his belief, he may find the experience of the foundryman with that class of service of great value to him. On the other hand, the engineer may have made previous experiments with both classes of steel and have found that, in his particular case, the class he specifies is, for some reason or other, better suited to the service than the class of steel the foundry has been in the habit of furnishing. When this is the case, of course, the foundry can secure valuable information from the engineer. Of course, in some instances the engineer is specifying the new class of steel in an experimental way. If he and the foundryman get together and discuss the question, the engineer may find that it will not be worth while to try his experiment because the foundry has tried it already. On the other hand, the foundry may well find that the engineer has good reason for trying his experiment, and by keeping in touch with the order and ascertaining its performance in service the foundryman may secure valuable data.

Another class of specification that gives great difficulty to the foundryman, is that specification in which both the chemical analysis of the steel and the physical properties which it must show are given in the specification. Sometimes, indeed, this is further complicated by the addition of a specified heat treatment. In many cases, of course, the analysis and the heat treatment specified will give the physical properties desired, but in far too many cases the foundryman on reading the specification finds that the physical properties called for cannot be secured in a steel of the analysis specified, or perhaps that the properties can only be secured by a heat treatment which is not allowed in the specification. Under these circumstances, the foundryman, in the lack of further data, is obliged to take his choice between making a steel which meets the chemical specification, and making a steel which shows the physical properties desired. Of course, if he discusses the matter with the specifying engineer, it can very soon be straightened out by altering either the chemical specifications or the physical specifications.

Value of Standard Specifications

A little consideration of the foregoing discussion will show the great value to both the specifying engineer and the foundryman of standard specifications prepared by societies of recognized standing, and adhered to by both the makers and the buyers of castings; but even some of these specifications prepared by national societies of recognized standing sometimes fall into the error of over-specifying. Thus, until this year the specifications of one of our national societies, if literally adhered to, would have ruled out of consideration all the ordinary steel castings made in a certain shop. The reason for this was that the specification as it read gave the physical properties desired in the steel, and also the method of heat treatment by which those physical properties should be secured. As it happened, the heat treatment specified was perfectly satisfactory to secure the desired physical properties in certain classes of steel, but the foundry in question was accustomed to secure the physical properties by special heat treatment of steel of a different class, and this heat treatment was forbidden by the strict letter of the specifications.

Castings Were Rejected

Too much stress cannot be laid on the importance to the foundryman of securing uniformity of specifications for steel castings on the part of various representative societies. To take a case in point, the author at one time had experience with an order for steel castings which formed parts of a steamship. It happened that these castings had to be accepted under three different specifications, all of them gotten by well-known organizations. These three specifications so overlapped that it was necessary to secure a steel having a very narrow range of tensile strength. The steel as finally turned out passed all the specifications except one, and it would not meet this specification because it had about 4,000 pounds too much tensile strength. The inspectors who were working under this third specification refused to accept the castings because while they showed considerably more extension, contraction and bend than was called for, and while the elastic limit was perfectly satisfactory, yet the steel was too strong. It seems almost too absurd for belief, but efforts had to be made to so heat-treat those castings as to take 4,000 or 5,000 pounds off the tensile strength, and it was found impossible to do this without making the castings fail in some other part of the specification. After a great deal of bother, the matter found its way up to higher authorities and the steel, of course, was then accepted as being a good deal better than the specifications called for.

The Steel Founders' Society is making every effort to secure uniformity of specification on the part of the various bodies who issue specifications for steel castings, and the author feels that this society should make every effort to further the good work.

The second great source of trouble in the steel foundry which can be remedied by co-operation between the designing engineer and the foundryman, is the design of the casting. There are so many different ways in which a design can be unsuitable for foundry work that it is not possible to mention all of them. Aside from the rather obvious error of specifying a casting so thin that it cannot be run in cast steel at all, the more common errors are, so designing a casting that it cannot be made without showing bad cracks, or designing it so that it cannot be made truly sound. The shrinkage of cast steel, being considerably higher than that of gray cast iron, is chiefly responsible for the difficulties with cracked castings. In many cases, of course, this is aggravated by higher sulphur in the steel than is desirable, and by the necessity of pouring the castings very hot. In a great many cases a customer who has been buying gray iron castings sends in his patterns to the steel foundry and desires to have them executed in steel without change of design. The foundryman looks the patterns over, and sees, for instance, that they contain thick and thin sections joining at a sharp angle and that it will not be possible for him to provide fillets or brackets at the junction of the two sections sufficiently strong to hold the casting together. Again he may see that fillets at the junction will serve to prevent the casting from cracking in cooling, but he finds that the engineer is unwilling to allow him to use these fillets. If the designer and the foundryman go over this matter together, it will generally be found that fillets can be used and in some cases, of course, removed after the casting is finished; or again that the design of the casting can be so changed as to make the sections far more uniform. The author has known many cases, which are probably common to the foundryman's experience, in which the casting could not

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—I

Letter	Name	Purposes for which suitable
B–c	Commercial brass...	Name and number plates; instrument cases; oil cups; distributing boxes.
Cu–r	Copper.....	Copper pipe and tubing.
F	Brazing metal.....	Brazing metal, and all flanges and fittings that are to be brazed.
G	Gun bronze.....	All composition valves 4 inches in diameter and above; expansion joints, flanged pipe fittings, gear wheels, bolts and nuts, miscellaneous brass castings, all parts where strength is required of brass castings or where subjected to salt water, and for all purposes where no other alloy is specified.
		Composition valves: Safety and relief, feed check and stop, surface blow, drain, air, and water cocks, main stop, throttle, reducing, sea, safety sluice, and manifolds at pumps.
		Condenser, Distiller, Feed-water heater, Oil cooler. (Heads, shapes and water chests.)
		Pumps: Air-pump casing, valve seats, buckets, main circulating, water cylinders, valve boxes, water pistons, stuffing boxes, followers, glands, in general the water end of pumps complete except as specified.
		Stuffing boxes: Glands, bushings for iron or steel boxes.
		Blowers: Bearing boxes.
		Journal boxes: Distance pieces.
		Miscellaneous: Grease extractors; steam strainers, separators, casing for stern tube and propeller shafts, propeller hub caps.
		Bearings: Main, stern tube, strut and spring.
		Spring bearings: Glands and baffles.
G	Gun bronze.....	Reciprocating engine: Intermediate and low pressure relief valves and casings, cross-head brasses, crank-pin brasses, eccentric straps and distance pieces.
H	Journal bronze.....	Journal boxes, guide gibs, bushings, sleeve, slippers, etc.
		Reciprocating engine: Valve stem crosshead bottom brass; link block gibs, suspension link brasses.
M	Valve bronze.....	All valves below 4 inches in diameter, for steam and general purposes, for which the material is not otherwise specified; hose couplings and fittings.
Mn–c	Manganese bronze..	Propeller hubs, blades, engine framing, and composition castings requiring great strength.
Mo–c	Monel metal.....	Same as for Mn–c, and pumpliners, valve seats, and castings requiring great strength, hardness and incorrodibility; shaft nuts and caps.
N–c	Cast naval brass...	Valve handwheels, hand-rail fittings, ornamental and miscellaneous castings, and valves in water chests of condensers.
P–c	Phosphor bronze....	Castings where strength and incorrodibility are required.
S–c	Screw pipe fittings.	For composition screwed fittings.
Ni	Nickel	For valve seats.
A	Admiralty metal...	Condenser, distiller, feed-water heater, and evaporator tubes.
B–n	Benedict metal.....	Condenser, distiller, feed-water heater, and evaporator tubes.
D–r	Muntz metal.....	Bolts and nuts not subject to action of salt water.
P–r	Phosphor bronze....	Pump rods, valve stems, valve springs, etc., exposed to salt water.
Mn–r	Manganese bronze..	Rolled rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility.
Mo–r	Monel metal.....	Rolled rounds, used principally for propeller blade bolts, air pump and condenser bolts, and parts requiring strength and incorrodibility, and pump rods.
N–r	Rolled naval brass..	Rolled rounds, used principally for propeller blade bolts, air pump condenser bolts, and parts requiring strength and incorrodibility, and pump rods, tube sheets, supporting plates, and shaft for valves in water heads for condensers.
B–r	Com'c'l rolled brass..	Sheet brass: For liners, trim, etc.
		Brass pipe: Boiler dry pipe, hand rails.
		Distributing oil tubes and water pipes.
		Commercial brass rod for trim, and purposes where strength and incorrodibility are not required.
W	Antifriction metal...	Lining bearings.

U. S. NAVY SPECIFICATIONS FOR NON-FERROUS METALS—II

Letter	Name	Composition by percentage					
		Copper	Tin	Zinc	Iron, Maximum	Lead, Maximum	Miscellaneous
B-c	Commercial brass	64–68	.....	32–34	2.0	3.0	
D-c	Muntz metal.....	59–62	.....	39–41	.....	0.6	
F	Brazing metal	84–86	.....	Remainder..	0.06	0.3	
G	Gun bronze.....	87–89	9–11	1–3	0.06	0.2	
H	Journal bronze....	82–84	12.5–14.5	2.5–4.5	0.06	1.0	
M	Valve bronze.....	87	7	Remainder..	0.06	1.0	
Mn-c	Manganese bronze*	57–60	0.75	37–40	1.0	.....	Aluminum, 0.5; manganese, 0.3.
Mo-c	Monel metal.....	Remainder	.....	.....	6.5	.....	Aluminum, 0.5; nickel, 60 (min.).
N-c	Cast naval brass...	59–63	0.5–1.5	Remainder..	0.06	0.6	
P-c	Phosphor bronze*..	80–90	6–8	Remainder..	0.06	0.2	Phosphorus, 0.3.
S-c	Screw pipe fittings, brass	77–80	4	13–19	0.1	3.0	
Ni	Nickel.....	.....	.....	.....	.....	.....	Nickel, 97 (min.).
Cu	Copper.....	99.8 (Min.)	.....	.....	.....	.....	To be free from sulphur and other impurities and metals.
Zn	Zinc (rolled plates for boilers or slabs)	.....	.....	98½ (Min.)	0.08		
Sn	Tin.....	.....	99.6 (Min.)				
Pb	Lead (1).....	.....	.....	.....	.....	Min. 99½	
	Lead (2).....	.....	.....	.....	.....	97½	
Mo-c	Monel metal (ingots or shot)	.....	.....	.....	3.0	.....	Nickel, 60 per cent (min.); manganese, 2 per cent (min.) balance copper, with amounts of other non-injurious ingredients.

* The figures given are approximate and are a guide as to the proportion of the elements except those for lead, aluminum, and iron, which are maximum limits.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, NOVEMBER, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

be made without serious cracking unless the distribution of the metal in the sections is radically changed. In some cases the casting will crack in cooling in the mold, and in some extreme cases it will come out so crookd that it will break in straightening or else give trouble in straightening, sometimes even necessitating straightening the casting hot.

Those of us who have had experience with the manufacture of alloy steels requiring special treatment know very well the difficulties of trying to execute castings in special steel that can readily be turned out in ordinary carbon steel. When patterns are sent in to us which were designed for ordinary steel with the request that we execute them as they stand, we are frequently in hot water, and finally either execute the castings with a change of design or let some other maker get costly experience trying to make them. In the cases where the pattern was designed for execution in cast iron, and is sent to us for execution in our special steel, the temperature of the hot water we get in is even higher. Our difficulties are considerably increased by the fact that the shrinkage of our steel is unusually high, so that we may have a casting crack in cooling; we may have it crack in heating up in the furnace; and again we may have it crack in straightening, especially as it is not feasible for us to put heat on our castings after their treatment is completed.

Sometimes castings are so designed that it is virtually impossible to make them truly sound. This is generally owing to the fact that the sections are so distributed that there is no place to put a sink-head of sufficient size or proper design to feed the fluid shrinkage of some heavy sections. The author has known many cases where conference with the designing engineer has led to a change in the pattern which enabled the casting to be made truly sound, and he regrets to state that he also knows of cases where no change was allowed and the foundryman just had to do the best he could. It is some satisfaction to state, however, that in a certain number of these cases he knows of the failure of the castings owing to almost complete unsoundness of some interior and important part, and that in those cases the designer of the casting generally had to accept the responsibility and to modify his design in accordance with the suggestions made by the foundry.

Can Foundry Sand Be Recovered Economically?

By H B Swan

THE subject of waste foundry sand and the problem of its reclamation is not a new one to foundrymen, but it seems necessary to emphasize the ever growing importance and need of systematic research to determine the possibility of reclaiming in a practical way the vast volumes of used molding and core sands, especially the latter, which are daily being thrown away as waste material.

For the purpose of determining the status of the waste sand problem throughout the foundry industry, and more as a "feeler" than for any scientific record, the following set of ten questions was sent out to a number of large foundries:

1.—How much sand do you use (in tons) per day?
2.—How much new core sand do you use per day?
3.—Is your foundry practice green sand or dry sand molding?
4.—Do you use oil or other materials for core binders?
5.—How much refuse sand do you dispose of daily (tonnage)?
6.—How do you dispose of it? (That is, do you load it on cars on your siding, or haul it away in wagons? Any details will be of additional value.)
7.—How much do you know or estimate it costs you per ton to dispose of it?
8.—Do you make use of any of your old core or molding sand? If so, what percentage?
9.—How much could you afford to pay for treating and using the whole or a portion of your old sand as against the cost of new sand?
10.—Any information which you may add, bearing upon the above questions, will be appreciated and used, without mentioning names, in the investigation of a method to make use of the foundry refuse sand, and open to members of the American Foundrymen's Association through its transactions.

The answers to questions Nos. 1 and 2 of course varied with the size of the foundry and the character of the work. To question No. 3, green sand molding is by far in excess of dry sand work, except in the steel foundries. In reply to question No. 4, oil, flour and pitch seem to be in almost universal use, all of which after baking and resisting the action of the metal leaves carbonaceous residues. In comparing the answers to question No. 5 with Nos. 1 and 2, it was found that in almost every case the amount of sand disposed of equals the amount of new core sand used, plus varying percentages of the molding sand used. Thus it would seem that in most foundries where dry-sand cores are used, no effort is made to re-use the burnt core sand, but that it all is disposed of as waste material. There are some exceptions to this, however, in special classes of work such as car wheels where as high as 50 per cent of the sand as removed from the cleaning room floor is used in the new core mixtures. In several cases the old molding sand is treated for re-use.

Referring again to question No. 6, it was found that with one or two exceptions the burnt sand was either loaded in freight cars or hauled away in wagons to some dumping ground, the cost of disposal varying from 30 cents per ton to $1.50 per ton. Two or three replies from larger foundries stated a cost of $24 per day to dispose of their burnt sand. While it is doubtless true that sand is the cheapest material which enters into the cost of the manufacture of castings, we find the cost of handling and disposing of it adds to its original cost as much as 100 per cent. This factor depends largely upon whether the sand is handled by mechanical means or hand labor; upon the situation of the foundry relative to dumping grounds, the latter condition in some cases of foundries located in large cities being a serious one; and also upon railroad facilities.

As exceptions to the rule we find one foundry disposes of some of its waste sand as a filler for a fertilizer; another writes that they have used some of their refuse sand for concrete mixtures. A portion of their experience is of interest: "We have used our burnt sand for putting in foundations for machinery, and we find that it serves the purpose very nicely, and in other places this burnt sand has been used in making cement floors, and these floors gave good service. We even used this burnt sand and burnt core sand in making concrete walls for a building, and the only bad effect that could be seen was that the flour in the cores made the walls flake. This flaking continued for a period of at least one or two years after the structure was completed and was very noticeable, especially after a continued wet spell. The flour which was mixed in this burnt sand was evidently not thoroughly saturated with moisture when the concrete was poured and upon long exposure to damp weather, it swelled sufficiently to flake

A paper read at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916.

off patches of concrete. In some cases only small parts the size of a dime, and in other cases larger patches the size of two hands came off."

The answers to question No. 8 verify what has been said above to the effect that many make no attempt to re-use either the burnt core or molding sand; a few treat a portion of the burnt molding sand for re-use; and with one or two exceptions the used core sand is entirely discarded.

In answer to question No. 9, many replies give no estimate; some state from 30 to 80 per cent of the original cost of the sand; whereas others give actual money values varying from 15c per ton to $1.50 per ton. Obviously the best way of estimating this is in a percentage of the original cost of the new sand, delivered.

The personal experience of the writer has been, in attempting to use burnt sand in new core sand mixtures that the cores are weak, soft, require an excessive amount of binder, and do not resist the action of the metal well. Even after burnt sand has been washed and cleaned, if examined under the microscope it will be found that the individual grains are coated with a black carbonaceous residue. These absorb an excessive amount of binder and where seacoal has been used either in facing sand or in the core-sand mixture, this has been coked and it is impossible from our experience to wash it all out. It must also be borne in mind that nearly all foundry sands contain a small amount of alkalis which are inimical to oil binders.

The Reclamation of Waste Foundry Sand

By H M Lane

IN THE past 20 years many attempts have been made to reclaim foundry sand. The principles covered in these experiments varied greatly, and the ultimate object sought also varied greatly. A process that is successful with steel foundry sand might fail utterly with brass foundry or aluminum foundry sand, owing to radical differences in characteristics of different materials. Steel foundry sand should be made up from pure silica sand, the grains of which are rounded rather than angular. This sand should then be bonded with a sufficient amount of refractory fire clay, so that it will hold its shape when rammed into the mold. All sand is damp, or as it is termed "green," when rammed in the mold. The bond must remain active whether the mold is poured when in the green state or is baked or skin dried. The percentage of fire clay used in such a mix is relatively small and the so-called wearing out of the sand is due mainly to the stopping of the fine passages by small grains, resulting in the breaking up of the larger grains under heat, and from dry or burned bond material.

Another interesting fact is that the mass law of chemistry influences very largely the temperature at which a given size of grains will start to melt or burn into the castings. Very fine sand will burn into a steel casting several degrees lower than coarse sand, and hence in this type of work we encounter the necessity of freeing the sand from these small and particularly angular grains. For such work a cleaning process that will remove the burnt clay and the fine sand dust is what is necessary. This may be accomplished by washing or dry cleaning.

For dry cleaning a number of systems have been devised, and some patents taken out. One system that has been used in the west, treats the sand with high pressure air in such a way as to cause the grains to impinge one upon another, giving a sand blast action which cuts off any adhering clay, scouring the grains. The system is then arranged to take away the fine dust and leave relatively clean grains. Other systems simply pass the sand through an apparatus which exhausts the finer dust without any attempt to give the sand a thorough scouring.

In this commercial world of ours, the process which will produce a product, just good enough for us to use, at the lowest cost, is the one that will ultimately be used, even if other systems may give a better though more expensive product. In steel foundry practice the ultimate factor is the cost of a ton of finished castings, and a process which recovers, let us say, 80 per cent of the sand in a fairly usable condition may be better than the one which recovers 90 per cent in a better condition but at a higher cost.

When we jump to the opposite extreme and try to clean or reclaim the exceedingly fine brass or aluminum molding sand we encounter a much more serious problem, and one which hardly is worth while attempting. It is, however, advantageous to clean the core sand. The statements thus far made have been with reference to molding sand. In steel foundry practice the core sand used is very similar to the molding sand and can always be cleaned to advantage. In the experiments which were made it was evident that at least 80 per cent of all waste sand material shipped out of the ordinary foundry can be recovered for re-use in some form. In the case of heavy gray iron work it can be dry cleaned, rebonded with proper kind of clay, and used as heavy work molding sand. In the case of aluminum and brass work the general run of sand from the foundry can be cleaned and used in core work with resin or water soluble binders. It, however, does not work well with oil. For the thorough cleaning of certain classes of sand, the wet process seems to be the best, but this necessitates first a scrubbing and then a washing, and takes quite a complicated plant, though the actual cost of cleaning per ton is low.

The foundryman is not interested in ultra or scientific processes, but is interested in the production of castings at a reasonable cost, and to accomplish this the simplest sand cleaning method available is what he wants. In some cases passing the sand over a series of sieves which will first take out the coarse waste material, and which will next remove the fine or dust material has been found to give a good product for rebonding for use in foundry work for a considerable line of gray iron castings. Each case, however, must be studied on its own merits, and local influences caused by the different grades of core and molding sand used have an important bearing on the subject.

A paper presented at the Cleveland meeting of the American Foundrymen's Association, Sept. 11 to 15, 1916.

The Cupola Tuyere Area

By W. J. Keep

Question:—What should be the tuyere area of a cupola lined to a diameter of 40 inches? What should be the height of the tuyeres from the bottom of the cupola, and how high above the tops of the tuyeres should the coke bed extend? What volume of air should be used in melting and what should be the blast pressure? Also let us know the proportion of coke to iron?

Answer:—We advise eight tuyeres with openings 6 x 6 inches through the shell. This will give a combined opening through the shell of 288 square inches or a little more than the area of a pipe 18 inches in diameter. The outside ends of the tuyeres

should have 6 x 6-inch openings and the inside ends should be 10 inches wide and 4 inches high, or even larger. If the tuyere area of your cupola approaches the foregoing dimensions, do not change it since it is advisable to have the tuyeres as nearly continuous as possible. The shell should be provided with angle iron rings spaced 4 feet apart, the first to be located 2 feet above the tops of the tuyeres, which will permit of renewing any portion of the lining. If you melt with coke on the bed and draw the iron as rapidly as it is melted, 12 inches is the proper distance from the bottom of the tuyere openings to the surface of the sand bottom. If you desire to accumulate a quantity of iron in a cupola, you must proportion the height of the tuyeres above the bottom accordingly. For melting one ton of iron, 30,000 cubic feet of air is required, the blast pressure varying during the heat, being lower if the tuyeres are large. If you operate a positive pressure blower, the pressure should be 16 ounces or 14 ounces with a fan.

You must determine the amount of coke required on the bed, and it is advisable to weigh out 2,000 pounds of fuel and charge a sufficient amount for the bed which will raise it 15 inches above the tops of the tuyeres. When you begin charging the iron, weigh the coke left on the charging platform and the difference will give the amount required for the bed of the cupola.

Each 2,000-pound charge can be melted with charges of 200 pounds of coke. We suggest that you make no change in your cupola, and if you had furnished the dimensions of your furnace and your methods of operation, we might have helped you without making changes of importance in the construction of your furnace or in your methods of melting the raw materials.

White Core in Cast Iron

By W. J. Keep

Question:—Among the castings poured from a recent heat of a very soft mixture was one which contained what appeared to be two distinct metals, one white and one gray. We would like to have you advise us what caused this peculiar formation.

Answer:—It is not an infrequent occurrence to produce a casting with a white center surrounded with gray iron and I have a sample ⅛ inch thick which has nine distinct layers of gray and white iron, the outside, however, being gray. As this casting solidified in a few seconds, the formation is unusual. Another interesting feature in this connection is that the iron which produced this result always is quite soft and gray. This phenomenon usually is the result of boiling iron on the wet cupola bottom, which is tapped into a green ladle and then poured into another green ladle, thereby causing it to boil three distinct times. Another peculiar feature if this is that this phenomenon cannot be produced after three distinct boilings.

Gaging Pattern Thickness

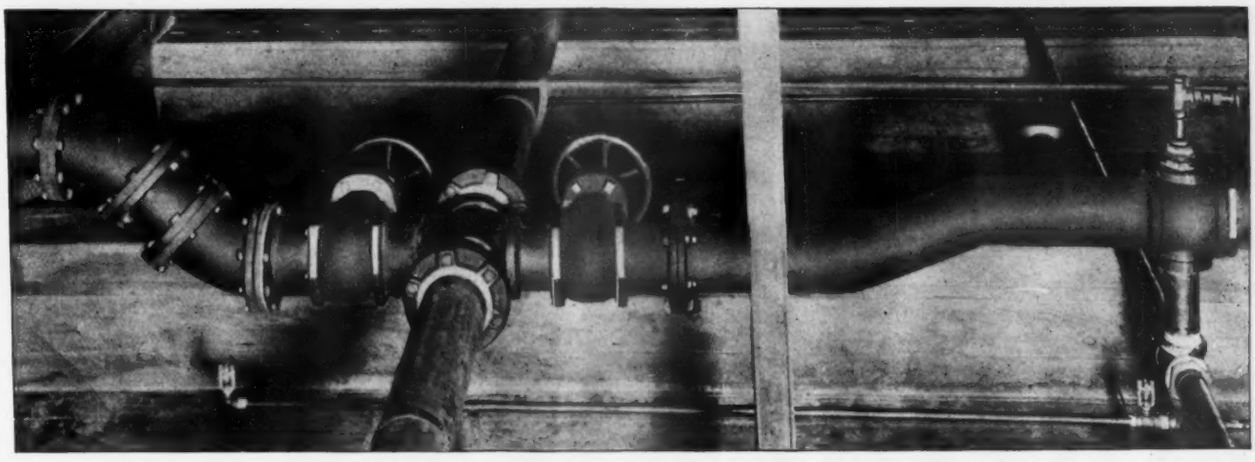
By J. A. Hughes

Some time ago we had to make a number of patterns of very irregular shape but of a constant thickness. Most of them were shields or flanges, no two portions of the surface being similar, making it a difficult matter to get the right thickness by means of inside and outside templates. In order to get the uniform thickness required, the fitting side of the pattern was finished and the opposite side roughed off with ⅛ or ¼-inch of finished thickness. Then we bolted a wooden block with a ball top to the drill press table and set in the drill chuck a fair-sized twist drill with the point ground to quite a flat angle. Next we fastened a steel clamp to the sleeve surrounding the drill press spindle above the frame, so adjusted that when it came in contact with the frame there was the required space between the point of the drill and wooden block fastened to table. Then by holding the pattern on the block and staggering a sufficient number of holes over the unfinished side, it was a simple matter to cut out the drill marks leaving the proper thickness all over.

Welding Large Pipe

The broadening use of oxy-acetylene welding in repair work is shown by an incident occurring recently at the Indianapolis plant of the Prest-O-Lite Co., manufacturer of dissolved acetylene. In extending the sprinkler system, it became necessary to run branches from a 6-inch water main. This main had been hung so close to the ceiling that offsets in the branches were required to clear the concrete girders and other piping already in place. Ordinary screwed fittings were employed until on one side a drop of 7½ inches was required, making impossible the use of these fittings with 6-inch pipe. This connection was finally made by using 45-degree flanged elbows and nipples, giving the pipe a 12-inch drop. The cost of this offset, including labor, was $17.50. With standard fittings, the job would have cost $5.66.

On the opposite side of the main, a different problem was presented. A downward offset of 5¼ inches was necessary to clear the pipes above and below the new line. It was decided that standard fittings could not be used, and an estimate was obtained on the cost of bending the pipe. This estimate was $18.60. One of the employes then suggested the use of oxy-acetylene welding and a short section, cut at each end at the proper angle, was welded into the line at a cost of $3.40. The accompanying illustration shows the completed job,



PIPE CONNECTION WELDED BY OXY-ACETYLENE PROCESS

Solving the Labor Problem in the Foundry

Foundrymen Find that the Adoption of Methods Which Promote Safety, Contentment and Efficiency Greatly Assists in Securing Reliable Workmen

By Luther D Burlingame

THERE are three important factors in production,—the equipment, the systems and methods employed, and the human element. While in the past greater weight has been given to the two former factors, and the human element has been allowed to take care of itself, a radical change is now taking place in the relative importance given to these factors, and it is being more and more appreciated that the human element is, in the last analysis, the one most important in securing the results desired.

Andrew Carnegie said, at the time when he was actively connected with the great steel industry, that if some great catastrophe destroyed all his steel plants and equipment, but left the personnel of his organization he would have courage to start anew; but if all his vast equipment remained and he had to build up a new organization from the beginning, with a new force of men, he would not feel that life was long enough to accomplish the task. It is not believed that any apologies are necessary in making the man, and the dealings with him, the subject of this address.

An address by Mr. Burlingame, who is industrial superintendent of the Brown & Sharpe Mfg. Co., Providence, R. I., before the New England Foundrymen's Association, Sept. 13.

How to Get Skilled Men

At this time when foundrymen as well as those having the management of other lines of industry are asking the question "Where are the skilled workmen? How can we supply the need?", it is well here pointedly to inquire: "What are you doing today to provide for this need in the future?" I believe there is only one answer to this question, and that is that every foundry should be training young men through apprenticeship to learn the various branches of the business as distinguished from men who are hired as operatives simply to perform one operation in which they can in a short time become reasonably skillful but which does not fit them for responsibility in the trade. I know the thought which comes into the minds of many, "It costs more than the returns we get. It takes the time of experienced men to instruct 'green' boys, and as soon as we have one trained, he leaves, and goes somewhere else."

It is believed that a systematic plan of apprenticeship entered into seriously, with terms just to both the employer and the apprentice, and with sufficient guidance and backing from the management, will bring results which will offset the objections just pointed out and that as a consequence the whole trade will profit from the results attained. A conference board on apprenticeship having representatives from the leading national organizations is now working on this problem.

At the foundry of the Brown & Sharpe Mfg. Co. the course of apprenticeship for molders occupies three years, the age limits at which boys are taken to learn this trade being between 17 and 20 years. They are paid 14, 16 and 18 cents per hour during the apprenticeship years. The apprentice pays $25 at the close of the trial period as a guarantee of good

FIG. 1—INTERIOR OF FOUNDRY OF BROWN & SHARPE MFG. CO., SHOWING EXCELLENT LIGHT AND VENTILATION TOGETHER WITH TRAVELING CRANE TO AID IN HANDLING WORK

faith or it might be considered as a payment for the privilege of learning the trade. At the successful completion of his term of apprenticeship he is paid a bonus of $100. These apprentices are given experience in bench work, floor work and in the core room. They also have during working time two hours per week of school work, devoted to subjects relating to their trade, and tending to increase their efficiency. This school work consists of simple mathematics, based entirely on foundry problems, and having to do with the sizes of flasks, the weight of iron poured, etc. The course also includes reading lessons in connection with foundry practice and methods.

Apprentices are also taken in the coremaking department for a period of one and a half years, the rates of pay for the successive periods of six months being 14, 15 and 16 cents per hour. In this case $25 is paid by the apprentice at the close of the trial period, and a bonus of $50 is paid him at the successful completion of his apprenticeship. In both these forms of apprenticeship the boys have piece work or job work during a considerable portion of their time, so that those who are efficient can earn materially higher wages than the scheduled rates.

Patternmaking, so closely allied to foundry work, also has its apprenticeship system, these apprentices serving for four years and being given some experience in the foundry during the course of their apprenticeship.

FIG. 4—SAFEGUARDING WATER SUPPLY

While a fair proportion of these apprentices remain, after completing their time, it is not felt to be wholly to the disadvantage of the company to have good men go out to other foundries, because, as in the case of machinist apprentices, they often become "missionaries" to make the name of their company widely and favorably known in a way to turn business later to the home shop.

In many cases these boys, even when they leave for a time, return later to become valued workers for the company.

Some time ago I heard Clarence H. Howard, of the Commonwealth Steel Co., say that when he went to take charge of that plant the first thing he did was to give attention to the boys, getting them together, becoming acquainted with them, and putting the stamp of his personality upon them. He took pains to impress upon them that the future managers and skilled workmen of that business were to be selected from among them and that it was worth their best efforts to fit themselves for such positions.

Sanitation and Health

After securing and training our men an important duty of the management is to see that proper provisions are made for their comfort, health and safety. These matters often become factors in determining whether a man will stay or leave and sometimes have a deciding influence rather than the question of pay.

Among the most important matters to consider are the provisions for an ample and pure water suply, and clean and ample wash and toilet rooms with lockers or other suitable provision for clothing, so separated from the smoke and grime of the foundry as to preserve the workman's self-respect when he changes his clothes to go on the street. Shower baths in connection

FIG. 2—APPRENTICE MAKING MOLD IN LIGHT FOUNDRY

FIG. 3—APPRENTICE MAKING MOLD IN HEAVY FOUNDRY

with this equipment are important adjuncts.

The securing of pure air and light is an especially difficult problem in the foundry and requires consideration at the time of the construction of the buildings. Successful provision along these lines, while also giving proper control of the temperature, should have much to do with comfortable working conditions.

While the important consideration is to keep men well provision for caring for them when ill also has its place. The service of a first aid department and a shop dispensary, where a skilled physician and experienced assistants are in attendance, can help cases of acute illness arising in the foundry and keep men at work who might otherwise be out on account of sickness. Such a service can also diagnose cases which may threaten to become more serious and so help the men as to avoid the consequences which might follow neglect.

For many years a relief association conducted by the workmen with the cooperation of the Brown & Sharpe Mfg. Co. has paid sick and death benefits which have been of material aid in bridging over times of greatest need. Plans to cooperate in an investment and insurance plan are also being put into effect.

Prevention of Accidents

The first aid and dispensary equipments can also be of direct help in case of accidents. The important consideration here also is to prevent accidents by safeguarding all places of danger, and to instruct the men along lines of safe methods of work.

In the Brown & Sharpe foundry much attention has been given to this matter of accident prevention. At times we have felt that we were making great gains in reducing such accidents but with the present congested condition of business and the necessity of hiring a large number of inexperienced men there have been periods of relapse when it has seemed impossible to keep down the accidents. Burning accidents are among the most serious in this foundry.

It had been thought at one time that the combination of congress shoes, inspected periodically to see that they were in good repair, together with leggings, which came over the tops of the shoes, would almost eliminate burning accidents to the feet. An early form of legging proved quite efficient in this respect but owing to its being attached by buckles, the process of removing it was found to be too slow, when a burning accident did occur. The N. A. S. O. legging was then substituted, a form with which foundrymen are now becoming familiar, through the fact that the National Founders' Association is represented on the board which is working to standardize matters of safeguarding. This style of legging snaps on to the leg in such a way that it can be readily removed in case of burning. It has, however, the objection that it easily rises above the shoe top, especially after becoming a little worn, or when used by a long-legged man, and burning accidents then occur, the hot iron entering at the top of the shoe. The use of a chain, passing under the foot, to hold the legging in place is being experimented with, as is also the manufacture of leggings of varying length to suit the workman. It is hoped that some still better method than any so far suggested may be brought to light which will entirely prevent these painful and slow-healing burns.

The "Booze" Question

The encouragement of sobriety and the securing of a sober class of workmen are direct factors in the promotion of health and the avoidance of accidents. There is a remarkable movement now going on throughout the industries to eliminate the drink evil and I believe it will be found that when normal conditions are restored —following the present situation where the demand for labor is so great that it is felt that some things must be "winked at" which ordinarily would not be tolerated—it will mean a still further elimination of those who are subject to the drink habit from the industries: this as a protection to the manufacturer against the enactment of compensation legislation, etc., and because of a growing conviction that the drink evil is a menace to efficiency.

Teaching English

A new labor problem comes from the bringing together of many nationalities, since a much larger proportion of workmen than in the earlier days are from countries where English is not the native tongue. This introduces not only misunderstandings, resulting in spoiled work and lowered efficiency, but in an increased accident rate and loss of time from sickness. Under these circumstances there is not the common ground of interest which formerly existed.

One step towards bringing about a better condition in this respect, which the foundryman can well consider a part of his legitimate work, is in taking such measures as are possible to teach the rudiments of English to workmen who need such instruction. The fact that it is often the workmen who need it most who are least responsive and require the most pressure to make them get the benefit of such teaching, makes the problem the more difficult. Coupled with this it is desirable to have these foreign-born workmen interested in becoming American citizens, and in identifying themselves with our institutions if they are to make their homes and bring up their families here as is usually the case.

It very easily becomes a habit, however, for foremen and fellow-workmen to treat this class of employes as mere numbered units in factory production without giving any thought to the fact that they are human beings, and it is believed that this is one of the important reasons for some of the serious labor troubles which have occurred. A little pains taken to get the workman's point of view and making him feel that there is a human interest taken in him and his welfare will, it is believed, largely overcome this feeling. It is important, however, that such dealings shall not be along paternal lines in a way to make the workman feel that he is being exploited.

Labor Question Complicated

The whole labor question is seriously complicated in these days by abnormal conditions, starting with the rush for munition work where in such centers as Bridgeport, Conn., the need of workmen becomes so great that many concessions were made to keep going regardless of the influence on the future and thus paving the way for the serious troubles which have been affecting not only New England but the whole country. A recent illustration is found in the threatened strike on the great railroad systems and the stepping in of the national Executive and congress to legislate so as to avert the strike, but in such a way as many of us believe will not permanently solve the problem but will simply encourage more serious disturbances as time goes on.

In recent years some investigations have been made to ascertain the cost of "hiring and firing" employes. All such investigations have shown that the cost is much greater than is commonly believed. Also, that when the figures are worked out, it is found that a much larger number of new employes are hired to maintain the force in a given year than should be necessary. With a true appreciation of the cost of this constant shifting of force and an earnest effort to remedy the difficulty, it is believed that not only the workmen themselves will be better off, but that the standard of efficiency in American foundries will be materially raised.

THE BRASS FOUNDRY

Chemistry in the Brass Foundry---VI

By E P Later

IN THE preceding articles of this series the determinations of the principal metals entering into the composition of ordinary brass and bronze, namely, copper, zinc and tin, were considered in detail; lead was included in the list as it may be regarded as a normal constituent of nearly all brasses, although the better grades usually contain only small amounts of it, while certain bronzes carry a considerable quantity; in many other alloys it is one of the principal components. A large number of special brasses and bronzes contain varying amounts of several other metals besides those considered previously, but it is obviously impossible to take up the determination of all of these. The brass foundryman is called upon, however, to deal with various other alloys, largely non-copper bearing, and it is believed that a short description of the best method of estimating several of the metals most likely to be found in these alloys will be of help. Incidentally, most of these metals may be found, at one time or another, in some of the copper-bearing alloys and their estimation may become necessary.

Aluminum is not found in the usual run of brasses or bronzes, but in the alloy known as aluminum bronze it is present in amounts up to 11 per cent; in addition it is used extensively in die-casting and other alloys, and the chemist is often called upon to determine the amount present in some material of this kind. Unfortunately, however, considerable manipulation usually is required to remove interfering metals to obtain the aluminum in suitable condition for estimating it.

This metal may be determined in any alloy containing it, by dissolving about one gram of the latter in 20 cubic centimeters of a mixture of one part nitric acid, two parts sulphuric acid and three parts hydrochloric acid, heating gently until solution is complete, then over a free flame until heavy, white fumes are given off abundantly. After cooling, 100 cubic centimeters of water and a few cubic centimeters of hydrochloric acid should be added and the whole heated to boiling until all soluble matter goes into solution; if a residue remains it should be filtered off, ignited with the paper in a crucible, then treated as before with the acid mixture, adding this solution to the other. Neutralize with ammonia then add about 5 cubic centimeters hydrochloric acid, dilute to 250 cubic centimeters or so, heat nearly to boiling and pass hydrogen sulphide gas through the solution for an hour, keeping the liquid hot to insure the removal of any arsenic which may be present; then it should be allowed to cool down to room temperature, maintaining the flow of gas in the meantime. The precipitate then may be filtered off, washing it with water containing hydrogen sulphide.

The filtrate should be boiled again until all hydrogen sulphide is expelled, then a few drops of nitric acid may be added and the boiling continued for a few minutes to oxidize any iron present.

Neutralizing the Solution

The solution next should be neutralized by the careful addition of ammonia, then sodium carbonate solution, taking care, however, to stop the addition of the latter reagent just before the point where the precipitate which is formed fails to redissolve. If through accident too much of the alkali is added and a permanent precipitate produced, it should be re-dissolved by a drop of hydrochloric acid and the solution neutralized again.

A solution of sodium hyposulphite should be added next until the liquid becomes colorless, waiting a moment after each addition of a small amount of the solution; this is followed by three cubic centimeters of a saturated solution of sodium phosphate and about six grams of sodium acetate dissolved in a few cubic centimeters of water, after which it may be boiled for an hour or so, or until it no longer smells of sulphurous acid. The precipitate may be filtered off and washed with hot water, then hot dilute hydrochloric acid, acid diluted with about twice its own volume of water, poured over it on the filter until it is entirely dissolved. To avoid using an excess of acid, the portion which runs through may be poured over the filter two or three times. The acid solution should be diluted to about 100 cubic centimeters volume with cold water, neutralized as previously noted, then a few cubic centimeters of sodium hyposulphite solution added, followed by a mixture of two grams of sodium acetate and two grams of sodium hyposulphite. After boiling for one-half hour the precipitate may be filtered off, dried, then burned together with the filter in a weighed crucible, heating gently at first then finishing at a low, red heat. The residue is aluminum phosphate, the weight of which, when multiplied by 0.2219, will give the weight of aluminum present.

Antimony is present, as a rule, only in small amounts in brass, to which it imparts certain desirable characteristics, but some bronzes contain somewhat larger amounts of it and pewter, brittania metal, type metal and other alloys of this kind contain varying, but considerable percentages of it.

One of the most satisfactory methods for the estimation of antimony involves titration with a standard solution of potassium permanganate, or certain other reagents, of a properly prepared solution wherein the antimony is present in what is known as the antimonous or lower state of oxidation and is changed to the antimonic or higher state.

The potassium permanganate solution required for this determination may be prepared by dissolving about 2.8 grams of pure potassium permanganate in a small amount of water and diluting to one liter, but before using this solution it will, of course, need to be standardized, which may be done by weighing out exactly 0.2 gram of pure oxalic acid crystals;

it always is advisable in work of this nature to weigh two or three separate samples, as a check may then be had on the determinations, and to dissolve it in 125 cubic centimeters of water containing about 7 cubic centimeters of sulphuric acid, in an 8-ounce flask. The solution should be heated to about 160 degrees Fahr., and add the permanganate solution from a burette until a faint, but permanent pink tinge appears.

The weight of oxalic acid taken, divided by the number of cubic centimeters of permanganate required, will give the value of the latter in terms of oxalic acid; this figure multiplied by 0.9532 will be the antimony value, that is, the equivalent value of each cubic centimeter in grams of metallic antimony.

Determining Antimony in an Alloy

Antimony may be determined in an alloy by heating one gram of it in a six or eight-ounce flask with a mixture of seven grams of potassium acid sulphate, one-half gram of tartaric acid and 10 cubic centimeters of sulphuric acid; the flask should be heated cautiously at first, then with the full heat of the burner until the mass is clean and light in color. The flask should be well shaken with a rotary motion while being heated and when this operation is completed it should be allowed to cool on its side, in order to prevent the melt from breaking it as it hardens.

When cool, about 50 cubic centimeters of water, 10 cubic centimeters of hydrochloric acid and three grams of tartaric acid should be added and the whole heated nearly to boiling for a few minutes to take all soluble matter into solution; then filter and wash the residue with hot water. The filtrate should be diluted to about 300 cubic centimeters with hot water and hydrogen sulphide gas passed through the warm solution for 10 or 15 minutes, to precipitate the antimony and whatever other metals of this group are present. The precipitate should be filtered off and washed with water containing hydrogen sulphide, then transferred to a beaker with a jet from the wash bottle, taking care not to use any more water than is necessary, and a few cubic centimeters of a solution of colorless potassium sulphide poured over it, warming slightly and shaking to insure the solution of the sulphides of antimony and tin. The solution now may be filtered through the filter which was used before and the precipitate washed with warm water containing a small amount of the potassium sulphide, allowing the filtrate to flow into an eight-ounce flask. Approximately 10 cubic centimeters of sulphuric acid and three grams of potassium acid sulphate should be added to this and the whole boiled, at last over a free flame, until most of the free acid and all of the sulphur has been driven off, after which the flask may be allowed to cool on its side. After cooling, 25 cubic centimeters of water and 10 cubic centimeters of hydrochloric acid should be added, heating if necessary to take soluble matter into solution, then the solution should be cooled quickly by letting cold water run over the flask until it has reached ordinary or room temperature, 40 cubic centimeters of hydrochloric acid added and hydrogen sulphide gas passed through for five or ten minutes, to precipitate any arsenic which may be present. The precipitate should be filtered off and washed with hydrochloric acid diluted with half its own volume of water; it is advisable to wet the filter paper with the acid before filtering the solution.

The filtrate should be diluted with about twice its own volume of warm water and hydrogen sulphide passed through until precipitation is complete; then the precipitate may be filtered off and washed with water containing hydrogen sulphide until the excess of hydrochloric acid has been removed and finally washed from the filter into a small beaker by a jet from the wash bottle, a small amount of ammonium sulphide solution added and the whole gently warmed. After allowing it to stand for a few minutes, this solution may be filtered through the last filter and the residue washed with water containing a little ammonium sulphide.

Diluting the Filtrate

The filtrate should be collected in an 8-ounce flask and to it should be added three grams of potassium acid sulphate and 10 cubic centimeters of sulphuric acid, after which it should be boiled as before to expel all of the sulphur and most of the acid. After cooling, the melt may be taken into solution with 50 cubic centimeters of water and 10 cubic centimeters of hydrochloric acid, boiling for a few minutes to drive off any sulphur dioxide which may be present, finally adding 10 cubic centimeters of hydrochloric acid and cooling quickly by allowing cold water from the tap to run over the flask, taking care, of course, that none gets inside. The solution then may be diluted to about 200 cubic centimeters with cold water, after which it will be ready for titration with the standard solution of potassium permanganate, this being added until a faint, but permanent pink color develops in the mixture.

Knowing the value of the permanganate solution in terms of antimony and the number of cubic centimeters required for titration of the antimony solution, the per cent of this metal present in the sample under examination may be calculated easily.

The antimony in alloys of this metal with tin and lead, babbitt metal and the like, often may be determined with less manipulation than in the method outlined, with results which are at least a close approximation and may be close enough for any ordinary purpose, by boiling one gram of the alloy for an hour with a mixture of one gram of potassium iodide, and 80 cubic centimeters of hydrochloric acid diluted with its own volume of water, in a beaker or flask. At the end of this time the solution should be filtered, after allowing the metallic antimony to settle out as much as possible, or rather, decanted, washing the metal several times with hot hydrochloric acid diluted with four or five times its own volume of water, and pouring the washings through the filter. The latter then should be washed thoroughly with the hot, dilute acid.

It will contain a few small particles of antimony and should be placed in a weighed porcelain crucible, moistened with nitric acid and the crucible heated gently until the filter is reduced to ashes. The remainder of the antimony in the beaker should be covered with a watch glass and warmed with a few cubic centimeters of nitric acid, which will convert the metal to a white oxide, and after the filter has been burned off and the crucible allowed to cool, this residue should be washed into the crucible, taking care not to use any more water than necessary. The liquid in the crucible then may be evaporated to dryness by the aid of gentle heat, proceeding cautiously at the end of this operation to insure against loss by spattering, finally heating to a low, red heat, then allowing to cool and weighing. The residue is antimony oxide, the weight of which multiplied by 0.7898 will give the amount of metallic antimony.

Determination of Iron

Iron is used in certain bronzes, Tobin bronze, delta metal, etc., to impart desirable characteristics such as hardness and strength; therefore, the estimation of this element occasionally may be necessary in alloys or in commercial metals where it is present as an impurity.

The volumetric method, by titration of the iron with potassium permanganate or dichromate after it has been

reduced to the ferrous or lower state of oxidation, in several ways, is the most convenient means of estimating this metal. The iron may be determined in an alloy by dissolving about one gram of the latter in 10 cubic centimeters of nitric acid, with the addition of a few cubic centimeters of hydrochloric acid if necessary to effect solution, in a large beaker. When the alloy is entirely in solution 10 or 15 grams of pure ammonium chloride should be added and the solution heated to boiling, then precipitated with an excess of ammonia, that is, this reagent should be added until a permanent precipitate appears and the solution smells strongly of it. The precipitate may be filtered off and washed well with hot water, after which a hole should be punched in the apex of the filter and the precipitate washed into a six-ounce flask with as small an amount of water as possible. Twenty-five or 30 cubic centimeters of hot dilute hydrochloric acid, one part acid to two parts water, should be poured over the filter to dissolve any of the precipitate which still adheres to it and the filter then is washed with a small amount of hot water.

Correct for Addition of Aluminum

The flask should be heated until all of the iron hydroxide is in solution, then concentrated somewhat by boiling and about two grams of pure aluminum sheet or turnings added. A definite amount of aluminum should be used as it always contains a small amount of iron which must be determined and corrected for. The iron solution will become colorless in a few minutes, indicating a reduction of the ferric iron to the ferrous state; then 30 cubic centimeters of dilute sulphuric acid, one part acid to two parts water, should be added and the flask filled to the neck with cold, distilled water, which should be allowed to run down one side so that the solution in the flask and the water do not mix. If necessary, the solution may be cooled to room temperature by allowing cold water from the tap to run over the outside of the flask, then the solid particles should be filtered out, catching the filtrate in a large beaker, 700-800 cubic centimeters, rinsing the flask and washing the filter well with cold water. After the filtrate has been diluted to about 700 cubic centimeters, it will be ready for titration and the permanganate solution should be run in from a burette, rather rapidly at first, until a yellowish tinge appears in the solution, then cautiously until a faint pink color develops. It may be noted here that placing a sheet of white paper under the beaker containing the solution to be titrated will assist greatly in the detection of the pink color. The burette reading now may be taken, but before calculating the amount of iron present in the sample it will be necessary to apply a correction for the amount of permanganate solution required to oxidize the iron present in the aluminum used for reduction and to produce a color in the amount of solution taken for titration.

Correcting for Permanganate

This may be done by dissolving the same amount and kind of aluminum as used before, about two grams, in a flask with 10 cubic centimeters of hydrochloric acid and 20 cubic centimeters of distilled water and when the action is well under way, 10 cubic centimeters of sulphuric acid diluted with 20 cubic centimeters of water should be added slowly. When the metal is all in solution the flask and contents may be cooled under the tap to room temperature, then filtered, diluted and titrated as previously noted, with the exception that more caution must be exercised in the addition of the permanganate since only a comparatively small amount will be required, as there is very little iron present.

The amount of permanganate required for this test represents the correction which must be applied to the results obtained in the determination of the iron in the alloy, that is, this must be subtracted from the amount of permanganate used in the determination. It is not necessary, of course, to determine the amount of the correction each time an analysis is made, since this will be a more or less of a constant factor, but it must be applied each time.

Standardizing Results

We now have the amount of permanganate actually required to oxidize the iron in the alloy, but do not know its value in terms of iron, hence it must be standardized. This may be done by dissolving about 0.2 gram of pure iron wire, which has been thoroughly cleaned of rust and grease, in 10 cubic centimeters of hydrochloric acid and six or seven of nitric acid, warming gently until the iron is in solution, finally adding six cubic centimeters of sulphuric acid and heating over a free flame until dense fumes come off. The solution then should be cooled and about 30 cubic centimeters of water and 10 cubic centimeters of hydrochloric acid added, followed by two grams of aluminum to reduce the iron. The procedure from this point is the same as that described under the determination of the iron in an alloy, that is, the reduced iron solution should be covered with a layer of distilled water, cooled and filtered, then diluted and titrated with permanganate.

From the amount of solution required to oxidize this known weight of pure iron there must be subtracted the amount needed to take care of the iron in the aluminum and produce a pink color in the volume of iron solution titrated, as previously described. The result will be the quantity of permanganate actually required for titration; therefore, the value of the permanganate solution in terms of iron may be found by dividing the weight of iron wire taken by the number of cubic centimeters actually required.

Standardization of the permanganate solution by means of oxalic acid, which is much less troublesome and perfectly satisfactory for our purposes, has been described previously. The oxalic acid value multiplied by 0.8867 will give the value of the iron in the solution.

Knowing the number of cubic centimeters needed for titration of the iron in a sample of alloy and the value of each cubic centimeter in terms of iron the per cent of iron present may be calculated by multiplying these two figures together, dividing the result by the weight of sample taken for analysis and moving the decimal point two places to the right.

Iron in Spelter

The amount of iron present in spelter is a matter of some importance since it affects considerably the value of the latter for some purposes and its estimation, therefore, often is advisable. As the amount of iron present usually is rather small a large sample, five or ten grams, should be taken. This should be put in a large flask and dissolved in 30 or 40 cubic centimeters of a mixture of one part hydrochloric acid and two parts water.

When the action has become less vigorous, 30 cubic centimeters of a mixture of one part sulphuric acid and two parts water should be added slowly and allowed to stand until everything soluble has gone into solution. The flask may then be filled up to the neck with cold, distilled water and the whole cooled to room temperature, after which the black residue should be filtered off as quickly as possible. After dilution of the filtrate to about 400 cubic centimeters, the solution may be titrated with the standard solution of potassium permanganate, adding the reagent, as usual, until a faint pink color develops. The number of cubic centimeters

of permanganate solution required multiplied by the iron value of each cubic centimeter and this result divided by the weight of the sample taken will express after moving the decimal point two places to the right, the per cent of iron present.

C. E. Liebenthal, in a general report on the production and consumption of lead, issued by the United States geological survey, shows that the output of refined lead in the United States from domestic ores in 1915 was 507,026 short tons, valued at $47,660,000, at the average price of refined lead in New York. In 1914 the output was 512,794 tons, valued at $39,998,000. Therefore, the production in 1915 was 5,768 tons less than in 1914, but owing to the higher price prevailing during the latter year, the gain in value amounted to $7,662,000, or nearly 20 per cent. The production in 1915 exceeds the output of each of the five preceding years. The statistics for 1915 show that Missouri, Idaho and Utah lead in the production of domestic ores, and that most of the foreign product is imported from Mexico.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Low Temperature for Babbitt Metal

In making babbitt metal we have experimented in pouring at different temperatures, namely 500 degrees and 900 degrees Fahr. The metal that was poured at the higher temperature had a dense grain that was deep gray in color, while the metal poured at a temperature of 500 degrees was more granular in structure. Which temperature, in your opinion, is the best and also in what manner should sal-ammoniac be introduced for use as the flux?

Pour the babbitt metal at as low a temperature as is consistent with the proper filling of the molds. In using sal-ammoniac it is not necessary to keep the surface of the metal covered. Merely add a small amount from time to time when the surface dross becomes mushy for the purpose of disentangling the dust-like dross from the metal.

Plaster of Paris Molds

Kindly let us know if it is advisable to make a temporary plaster of Paris mold suitable for making castings in type metal. We have experimented with pure plaster and find that the lead bubbles when poured into it. Stearine is used to effect a separation of the original pattern and the plaster mold and this penetrates the plaster and we believe that this caused the bubbling of the metal. Therefore, we have attempted to burn off the stearine, but find that this makes the mold so friable that it breaks. Is there any way to avoid this and to make a mold from which we can obtain about six casts of type metal?

When making plaster of Paris molds it is customary to add brick dust to the plaster in the proportion of two parts of brick dust to one part of plaster of Paris. For strengthening the mold a small amount of comminuted asbestos also is added. Before using the mold it should be dried thoroughly, and if in the experiment outlined the mold was not absolutely dry, it was due to the fact that it was permeated by stearine. Plaster of Paris molds cannot be used more than once and we suggest that after the sections of the mold are obtained in plaster that they should be used as patterns and brass sections be cast therefrom. If the molding is carefully performed, the bronze castings can be assembled easily to form a mold from which an unlimited number of lead castings can be obtained without risk.

Flux for Melting Scrap Brass

What is a good flux to use for melting large amounts of scrap brass? Will manganese-copper remove the sulphur from this material and will it prevent the metal from absorbing sulphur while being melted?

The following flux can be used to excellent advantage to exclude the air when melting scrap brass: Lime, 30 per cent; powdered fluor spar, 20 per cent; powdered charcoal, 20 per cent; common salt, 10 per cent, and soda ash, 20 per cent. If too fluid, increase the percentage of lime and decrease the percentage of soda ash. Manganese will not prevent brass or bronze from absorbing sulphur. Also, it is questionable whether manganese will remove the suphur that has been absorbed, although it has a greater affinity for sulphur than copper. In addition, low sulphur fuel should be used in melting.

Mixture for Motor Car Pistons

We would like to have a formula for motor car pistons which should be light and strong. Also, we would like to have a mixture for bushings for automobiles.

The following alloy is being used extensively: Aluminum, 95.75 per cent; copper, 2.50 per cent; tin, 0.75 per cent; iron, 0.75 per cent and magnesium, 0.25 per cent.

Difficulties Caused by Hard Ramming

In making ¾-inch brass rod we recently have experienced considerable difficulty due to the porosity of the metal. One-half of every casting poured with this metal is full of blowholes, while the other half is sound and we are unable to account for this, as it has never occurred before in our experience. The metal consists of a mixture of 90 per cent red brass scrap, such as valves, and 10 per cent of copper.

From the sample submitted, it is our opinion that the origin of the difficulty lies in the molds, as the sound portion of the metal shows that the trouble is not due to oxides. The molds have been rammed too hard and we are inclined to conclude that only one-half of each mold was so treated, probably the cope. A little attention at the molding end will overcome this difficulty and will provent its repetition.

An Alloy Giving High Tensile Strength

We have received an order for an alloy which must meet the following physical requirements: Ultimate strength, not less than 60,000 pounds per square inch; elastic limit, not less than one-half the ultimate strength and elongation, not less than 25 per cent in 2 inches. This mixture must contain not less than 60 per cent copper, 0.5 per cent tin and the balance of zinc and other metals. We have been asked to make a quotation on this alloy and will appreciate a prompt reply.

It will be necessary to use manganese bronze in this case to meet the provisions of these specifications. The following alloy will meet the necessary requirements: Copper, 52 pounds; zinc, 46 pounds; iron, 1 pound; tin, 1 pound; 30 per cent manganese-copper, 6 pounds,

and aluminum, ¼ pound. Three test bars made of this alloy gave the following physical properties.

(1) Ultimate strength, 71,800 pounds per square inch; elastic limit, 30,800 pounds per square inch; elongation in 2 inches; 36.5 per cent and reduction of area, 33.7 per cent.

(2) Ultimate strength, 70,800 pounds per square inch; elastic limit, 30,800 pounds per square inch; elongation in 2 inches, 26.5 per cent and reduction of area, 25.7 per cent.

(3) Ultimate strength, 72,300 pounds per square inch; elastic limit, 30,700 pounds per square inch; elongation in 2 inches, 32.5 per cent and reduction of area, 30.7 per cent.

Plaster Molds for Lead Toys

With further reference to the production of lead toy castings, I would like to know what causes the difficulty in lifting the plaster from the lead. Plaster of Paris seems to have a special affinity for lead, notwithstanding the fact that it is well coated with grease. We would like to know whether the plaster would adhere less to brass or copper than to lead. What is used to prevent one-half of the plaster mold from adhering to the other half? Can oil be used for this purpose? Perhaps the oil might rot the fine, raised portions of the plaster, and we do not want to use too much of this as it fills up the outlines of the pattern.

Considerable skill is required to make plaster-of-Paris piece molds and no amount of written advice will enable one to master the art. If the one making the molds is not proficient, it will be far more economical to have the molds made by those who are experienced in this line of work. If the bronze molds are not properly parted and fitted, the lead figures will be unsightly and in all probability will be rejected by the purchaser. It will prove a good investment to spend a considerable amount of money on the molds, since they are permanent and upon them depends the salability of the product. Plaster of Paris should part easily from oiled or greased surfaces and the use of petroleum jelly is recommended as the medium for oiling the partings of the plaster surfaces.

A Sulphuric Acid Resistant

Will any alloy or metal, other than lead, resist sulphuric acid?

"Duriron" will resist sulphuric acid satisfactorily. It is a high-silicon cast iron which is very resistant to all strengths of this acid. It anaylzes as follows: Silicon, about 14 per cent; manganese, about 0.25 per cent; phosphorus, 0.16 per cent, and sulphur, less than 0.05 per cent.

Air Pocket in Brass Shells

We are making brass shells about 3 inches in diameter and 3/16 to ¼-inch thick, but an air pocket forms between the outside and the inside surfaces of these shells. We would like to know what causes this pocket and how it may be remedied. Our mixture consists of copper, 85.5 per cent; tin, 2 per cent; lead, 9 per cent, and zinc, 0.5 per cent.

Air pockets in castings are caused by neglect in melting the metals in which these defects occur. The remedy is to cover the surface of the metal with charcoal or some flux that will exclude air, thus preventing oxidation. In thin castings, air pockets, as they might be termed, sometimes exist as lateral cracks and may be so extensive that a cast plate can easily be split into two halves when the edges are machined off. This type of air pocket is not caused by air at all, but is due to shrinkage. It may be prevented by increasing the fluidity of the alloy by the addition of phosphorus. In the case of the alloy given the addition of 0.5 per cent of 15 per cent phosphor-copper should correct the difficulty.

Segregation Caused by Phosphorus

We are making bronze bushing shells of the following alloy: Copper, 85.50 per cent; tin, 5 per cent; lead, 9 per cent, and zinc, 0.5 per cent. We experience considerable difficulty from the splitting of the metal when the castings are tinned. The air in this slight fissure expands and this results in explosions that are liable to seriously injure the operator who is tinning the castings. The metal for the bushings is melted in pit furnaces and is kept well covered with charcoal, a small amount of phosphorus being used for cleansing purposes. Any suggestions that you can make that will help us overcome our difficulty will be appreciated.

The use of phosphorus in alloys of this type is inadvisable since it is productive of segregation in the castings which are poured in sand, or castings that are slowly cooled. To test this, mold two bars, each 1 inch square and 8 inches long and cast them separately. Pour the one from the phosphorized alloy and the other one from an alloy that contains no phosphorus. When cold, nick the bars, break them and examine the fractures. The one containing the phosphorus will show an uneven fracture, while the other will be uniform. The yellow spots in the phosphorus bar are areas of porosity, that is, the spaces between the crystals are voids, while the denser portions next to the sand will be gray in color and the spaces between the crystals will be filled with a blue eutectic. It seems as if there is not sufficient eutectic to go around, a condition fostered by the phosphorus and, therefore, it is advisable to omit the latter, as the spots in the square bar and the void in the center of the thin castings have a similar origin. Instead of the phosphorus, place in the bottom of the crucible 1 per cent of barites or barium sulphate and do not permit the castings to cool in the sand. If they can be dipped, this will be preferable to sand cooling. However, if this treatment does not effect a cure, decrease the lead and increase the zinc proportionately.

Segregation of Copper and Lead

We are experiencing difficulty from segregation in casting an alloy consisting of 40 per cent lead and 60 per cent copper. Kindly let us know how to proceed to secure sound castings.

Sulphur generally is employed for bringing about the union of copper and lead. It can be added in the form of a sulphate, such as plaster of Paris, or as rolled sulphur. No greater amount of sulphur should be employed than is necessary to hold the two metals together and, therefore, it is advisable to do a little experimental work to determine the proportion best suited for the work in hand, since melting practice and the quality of the molding sand, in a measure, will influence the results. Begin your experiments first by the use of 1 per cent of plaster of Paris, together with a small amount of borax, or you might try 0.25 per cent of roll sulphur. Thoroughly stir the metal before pouring, but if unsuccessful in getting a homogeneous mixture, do not be discouraged, since the desired results can be attained without much difficulty. Therefore, repeat the process and the segregation difficulties which you are experiencing soon will disappear.

Mixture for Brass Valve

We have an order for a large valve which must withstand a pressure of 300 pounds per square inch. The metal, of course, must not be porous and the valve is to be brazed to copper tubing. We would like to know what mixture is best adapted for this purpose.

The following formula will be found satisfactory for the purpose outlined: Copper, 86 per cent; tin, 8 per cent; zinc, 4 per cent and lead, 2 per cent. Whether or not the metal will be porous will depend entirely upon the skill with which it is melted. The copper should be melted under charcoal, with the addition of a small amount of common salt, and when it is ready for pouring the metal must be immediately removed from the furnace.

Making Thin Wall Ornamental Brass Castings

The Preparation of Sand is an All Important Feature of the Successful Manufacture of Cash Register Cabinets—The Walls of the Castings Are 0.1-Inch Thick

By R S B Wallace

THE manufacture of thin-walled ornamental castings of large area in brass and bronze has experienced a remarkable development during the past few years. The old process of smoking, double facing and extensive drying has been largely supplanted by less complicated methods. In this article the writer will outline the successive operations in making the ornamental castings required for the cabinet, or outside case, of a cash register.

From experience we find that the amount of attention paid to the facing sand used in making thin-walled ornamental castings has a direct influence on the results obtained. Many castings are thrown in the scrap heap on account of poorly prepared sand. A fine heavy-bonded Albany sand is used in making our facing. It is added in the proportion of one part new Albany sand to six parts old sand, adding six ounces of salt to each gallon of water used. The new sand is dried in a large drying bin, in which there are a number of steam pipes, until it will pass through a No. 40 mesh sieve. If necessary, it is milled before being placed into the sieve, and any small stones that may be in it are first removed. After the sand has been riddled it is placed in bins convenient to the sand mixing machine. Uniformity of the mixture of old and new sand is controled by the sand hopper on this machine, which has two compartments both containing worms geared in the ratio of one to six.

The sand, after being moved out of the hopper by the worm, falls on the riddle, shown in Fig. 1. This riddle is suspended from the hopper by four flat springs, and is operated by compressed air. It is 3 feet 2 inches long and 20 inches wide, fitting closely to the sides of the frame and held at the ends by wood blocks. The frame which holds this riddle is 4 feet long and 22 inches wide. The frame and riddle are slightly higher at the discharge end, keeping the sand at the end of the riddle nearest the cylinder, but this does not prevent the coarse material from passing out through the opening at the end of the riddle. Two cross bars are placed in the riddle about 12 inches apart and 12 inches from the end. This breaks the lumps in the sand and a ½-inch clearance above the screen allows the coarse material to pass through. All the small particles of rust and foreign matter in the heap sand are thrown out at the discharge end, which, with another style of riddle, is broken up and passed through the screen.

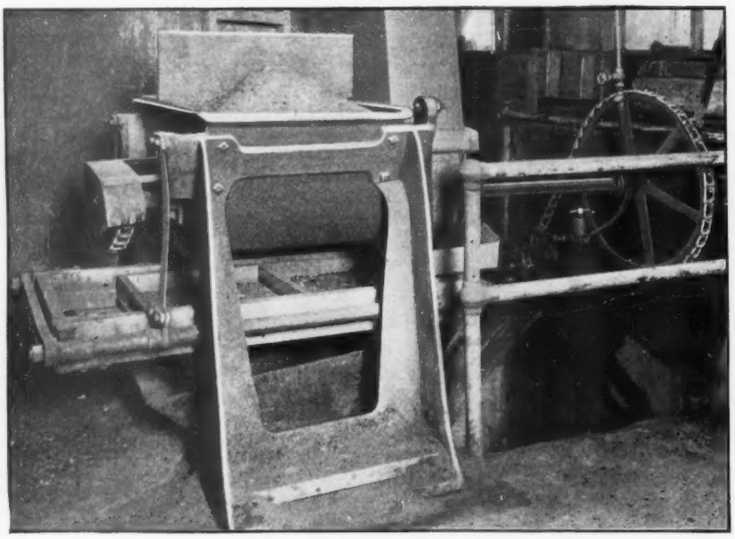


FIG. 1—SAND HOPPER AND PNEUMATIC RIDDLE

After the sand has been prepared it is allowed to stand at least 24 hours, which gives it time to temper. It is then delivered to the molder, being placed in specially provided boxes convenient to his place of work. The sand used in the heap should be as open as possible so as to allow the gases to leave the mold freely when being poured. Plenty of new sand should be used in the heap as it will become closer with each day's use. We find it much better to add a shovel of new sand after each heat rather than large quantities at one time.

All flasks used are made of cast iron and have machined joints. Due to the closeness with which it is necessary to work, little sand bearing is allowed, and when the parts of the flasks are clamped together the joints fit close so the edges of the mold will not crush. It is very important that the back plates be straight, and when boards are used care should be taken that they do not become warped, as castings which require a uniform thickness cannot be made if the plates or boards are not straight. When castings of large area are made, the pattern should be placed on hard sand or a plaster match, and it is very essential that the pattern be not allowed to spring as misrun or over-size castings will be the result. All molding tubs and machines are equipped with vibrators which eliminate the rapping of the pattern and more uniform castings are obtained. All molding machines are equipped with lifting devices, which permit the making of a mold with very small degrees of draft, less skill being required, especially where deep lifts are made. In all cases the mold is lifted from the pattern. Great care is given the flask pins, and pin holes in flasks and pattern plates, as shifted castings, which cannot be used, are the result if these parts become worn. No molder is allowed to tighten or loosen pins; this is done in the machining department, where they are properly equipped with tools and a templet to adjust the flask pins. A steel machined strike-off is given to each molder, or machine operator, which is checked up for accuracy at frequent intervals by the foreman. This is very essential as a hollow or high place in the back of a mold will cause misrun or oversize castings. With straight back plates and a straight back to the mold uniform castings are assured.

Presented at the annual meeting of the American Institute of Metals, Cleveland, Sept. 11-15, 1916. The author is foreman of foundries, National Cash Register Co., Dayton, O.

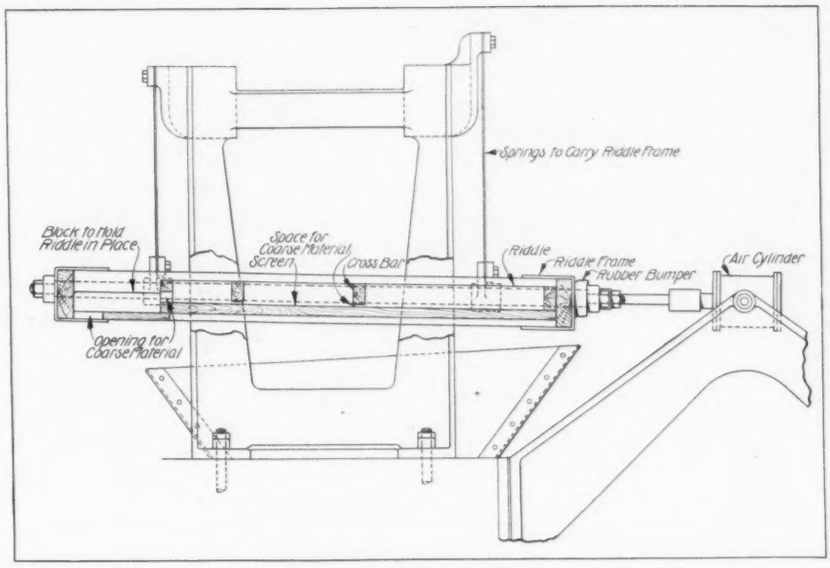


FIG. 2—DRAWING OF PNEUMATIC SAND RIDDLE

A number of different makes of molding machines are used, each type being equipped for a special class of work or for the work for which it is best adapted. In the use of the lifting device it is necessary that the lifting pins are at all times carefully adjusted. Air gauges are used on the power machines so that each job can be rammed as hard as required and all molds rammed alike.

Methods of Molding

Whether a mold is made on a machine, tub or floor, the process and operations are very much the same. All tools required by the molder are furnished by the company, and the molds must be made according to the instructions given by the foreman. The pattern is placed in position and the flask is put over the pattern. Where a flat surface is formed, pulverized charcoal is used as a parting; where lifts are necessary, a parting compound is used. Pulverized charcoal is given the preference because it does not stick to the pattern, therefore, the finer details in the casting are brought out much sharper. After the parting material has been put on the pattern, a thin layer of facing sand is next riddled over the pattern, using a No. 10 mesh sieve. Then a shovel of heap sand is riddled over the facing sand, using a No. 4 sieve. This is done to cover the pattern with a layer of sand without the sand being moved on the pattern, which is often the cause of castings showing a roughness along the edges of the ornaments or border, commonly known in the foundry as a ram-off. In shoveling sand in a mold that has a very light layer of riddled sand over the pattern, the sand may slide, causing rough edges on the casting. A mold must be rammed firmly and evenly. The sand around the edges of the flask must be peened, and then rammed hard enough so as to remove any danger of the mold sagging. If this is not done, the mold sags and misrun castings may be the result. The general rule followed is to work the sand as dry as possible, which, when properly rammed, will give a good casting. Wet sand is always to be guarded against as much as possible, as a large number of spongy castings are due to wet sand and not to metal, as is most often believed. After the mold is rammed, it is struck carefully so as not to leave any high or low spots in the back. A small amount of sand is placed on the back of the mold and the plate or board firmly bedded in place. When the mold is lifted from a drag or pattern plate, it should not be jarred, as this frequently causes misrun castings.

Gates are attached to all patterns, as cleaner castings are assured when gates are rammed with the pattern, than when they are cut by the molder after the mold is rammed. A small amount of flour is shaken on the mold, using a sack for this purpose, care being taken to blow off the surplus from the mold before the moisture in the sand takes hold of the flour, as only a thin film is required. Excessive use of flour would make a rough casting. The mold is now ready to be closed after being blown off by the bellows. The mold, if exposed for a few minutes, will receive a sediment of fine dust, which is in the air of all foundries, and must be removed. The mold should be clamped very firm, as heavy or oversize castings would be the result if the mold is not clamped hard enough to withstand the pressure of the metal when it is poured.

Must Molds Be Dried?

A few years ago it was thought necessary to dry all molds for both brass and bronze, but at present only molds for brass castings having large area are dried; in some cases good results are obtained by drying only one side, the other side being entirely green. It was also thought necessary to pour all castings with the ornament or face side down. This rule is not always carried out now, as we find that ornamental castings, with deep borders or high ornaments, can be made cleaner and sharper by pouring face side up.

The thickness allowed in the main body of all castings of register cabinet parts is 0.10 inch. Therefore very hot metal is essential, and the rule is strictly carried out that the molder must be ready for his metal when it has reached the proper temperature. All the metal used for casting purposes is melted in coke-fired pit furnaces. These are made in three sizes.

MELTER'S STOCK RECORD Date

Copper	Mix	Back-stock	Brass	Alumi-num	Nickel	Zinc	Tin	Lead	Antimony	Total Wt.

Furnace — Moulder — Melter — Weigher — Remarks

Heats	1	2	3	4	5	6	7	8	9	10	11	12
Metal												
Crucible												

1619—2-23-16-E

FIG. 3—FACSIMILE OF MELTER'S STOCK RECORD CARD

The smallest take up to a No. 30 crucible; the next up to No. 40, and the largest up to No. 60. From three to six heats a day are taken from each furnace, depending on the amount of metal required. Each molder has a furnace allotted to him, which is in the care of a melter, who is held responsible for the melting. Each melter is required to look after five furnaces. To avoid confusion in handling such a large number of heats, required for a day's melting, a melter's record card, shown in Fig. 3, is used. One copy of this goes to the melter with the metal and the other is delivered to the foundry office, where it is used as a check against the foundry by the stock room that issued the metal.

Many Alloys Used

Forty different alloys are used in the various parts of cash registers, but for cabinet parts, only two are used. The bronze finish parts are a composition consisting of 86 per cent copper; 1.5 per cent tin; 11 per cent lead, and 1.5 per cent zinc. The manganese-copper content is 1/20 ounce per pound of copper.

The nickel-plated parts have a composition consisting of 70.5 per cent copper; 26.5 per cent zinc; 2.0 per cent lead, and 1.0 per cent tin.

In all mixtures the zinc, tin and lead are made into alloys which reduce the cost of weighing the necessary metals and eliminate the chances of error. For the bronze finished mixture it is very important that the metal be of the same composition at all times, as the various parts of a single cabinet may be made by a dozen different molders and a dozen men may have melted the metal, but when the parts are assembled, they must match in color.

In melting the metal, it must at all times be covered with charcoal. After the crucible has been placed in the furnace, and the necessary coke placed around it, a few pounds of gates or scrap metal of the same composition as that required in the heat, are placed in the bottom of the crucible. The copper is placed across the top of the crucible at the same time. By the time the gates are melted the copper is ready to be placed in the crucible and as the copper melts it falls into the bath of metal made by the melting of the gates. After the metal has become properly melted, the necessary alloy is added in proportion to the amount of copper. At this point the metal should not stay in the crucible over 10 minutes, which is ample time for the alloy to become mixed with the copper and be brought up to the required pouring temperature.

The castings are conveyed to the cleaning room on industrial railway trucks, care being necessarily used in loading, so as not to scratch the ornamental side of the casting. The first operation in the cleaning room is to brush the sand from the casting. This is accomplished by revolving circular wire brushes which are attached to a universal jointed shaft over openings in a bench. These openings are connected with an exhaust for carrying off the sand and dust. The parts are then passed to the band saws, where the gates are sawed off. The band saws used on these machines are 18 feet long, ½ inch wide and have 14 teeth to the inch. The saws are carried over wheels 3 feet in diameter, running 375 revolutions per minute. The work is then passed on to the grinding lathes, where the gates are ground off and any burrs or rough edges on the castings removed. The grinding is done on circular carborundum wheels, 16 inches in diameter, operated at a speed of 1200 revolutions per minute. From the grinder, the castings go to the dipping vat, where they are pickled to clean off any sand stains and sand not removed by the first operation of brushing. The pickling operation consists of placing the castings in large bronze racks, which carry about 500 pounds of cabinet castings and immersing them in a diluted solution of hydrofluoric acid, one part acid to six parts water, for about 30 minutes. The baskets, or racks, are transferred from point to point by means of a trolley system and are raised and lowered by an electric hoist. After the castings have been in the pickle the necessary time, they are rinsed in consecutive baths of cold and hot water. Finally they are placed in a drying oven until thoroughly dry, when they are delivered to the inspector.

Chilling Sheave Wheels

By G. S. Evans

Question:—We are experiencing considerable difficulty in making sheave wheels which are to be chilled on the rim to a depth of ⅜ inch. We are using a mixture of Middlesborough iron, Nos. 3 and 4, but despite the fact that we are using a chiller, we connot obtain the depth of chill required.

Answer:—The mixture which you are employing is not adequate for the purpose and we suggest that you use, car wheel scrap, 30 per cent; gray iron scrap, 35 per cent; Middlesborough pig iron, No. 3, 20 per cent, and light scrap steel, 15 per cent. When this mixture is properly melted and poured at the right temperature, it will produce a chill of ⅜ inch. If a higher chill is desired than can be produced by this mixture, increase the percentage of scrap car wheels and steel and reduce the gray iron scrap and pig iron. With a little experience you will be able to re-arrange these percentages so as to produce the desired chill.

A good method for ascertaining the chilling capacity of your iron before casting it into pulleys, is to test the metal from each tap by cast, chill test ingots, 1 x 2 x 4 inches, with the 1-inch face of the ingot against the chiller. You soon will be able to judge the ratio between the chill on the ingot and that on the pulley, so as to enable you to know what amount of chill you are getting from each tap without the necessity of breaking the pulleys to determine this.

The chiller you are using is adequate to chill a casting of this size to ⅜ inch, although you might add 1-inch to the back side of the chiller if a deeper chill is desired, but you cannot hope to obtain more than 1/16-inch additional chill from this expedient.

The pulleys should be cooled slowly and if possible, they should be placed in a soaking pit. They should be shaken-out as soon as they can be handled without breaking, and should be pitted as rapidly as possible to retain the heat. This will soften the hubs so that they can be machined more easily and at the same time will relieve any shrinkage strains that are set up in the wheel as the result of the chilling of the groove. If a soaking pit is not available the wheels should be left in the sand until cold.

If it is found that chilling the pulleys to a greater depth than indicated, causes the spokes to crack when allowed to cool in the sand, this can be overcome by increasing the manganese content by adding ferro-manganese to the mixture. If this fails to stop the cracking, the only alternative would be to cool the castings in soaking pits.

W. H. Christy, formerly superintendent of the Bessemer Foundry Co., Grove City, Pa., and H. S. Chambers, of the Burrows Foundry Co., Ellwood City, Pa., have purchased the Burrows plant, which will be operated under the name of the Lawrence Foundry Co. Equipment is being installed to increase capacity from 10 tons to 35 tons a day of gray iron castings.

Charles V. Bower has resigned as general manager of the Trenton, N. J., works of the National Radiator Co. William S. Stiles has succeeded him.

Fatalities in Foundries Must Be Eliminated

Detroit Congress of National Safety Council Gives Enthusiastic Impetus to Movement for Fewer Accidents—Manufacturers Exhibit Safety Devices

THERE is no excuse for a fatal accident in a shop, even where molten metal is handled". This paraphrase of a statement by Dr. F. L. Hoffman, statistician, Prudential Life Insurance Co., Newark, N. J., strikes the keynote of the special meeting on foundry safety held in connection with the fifth annual safety congress at the Statler hotel, Detroit, Oct. 18. It is evident that foundrymen the country over are determined to completely eliminate shop fatalities and to reduce non-fatal accidents to a minimum.

The safety congress was attended by over 1,000 delegates from representative American industries. The program, which covered four days, Oct. 18 to 20 inclusive, carried the names of 140 speakers. The tremendous momentum that has been attained by the safety-first movement was forcibly demonstrated, and it is now clear that the safety idea is no longer dependent for its driving power upon the agitation of a few persons. The promotion of safety has become the life work of thousands of hard-headed, practical men, and a well organized safety bureau is as essential to a modern industrial establishment as an accounting department.

Foundrymen are Prominent

Amid the complex activities of the fifth annual safety congress, the interests of the foundry business were prominent. The work of the congress, is divided among several sections, each catering to a special line of industry. This year, for the first time, a section was organized to consider the safety problems of the foundry business and a special session was set aside for foundrymen on Wednesday morning, Oct. 18. Approximately 200 representatives of American casting plants participated in this meeting. The papers were interesting and the discussions brought out many points of practical value. The meeting was presided over by O. J. Fehling, manager, National Malleable Castings Co., Chicago, chairman of the foundry section.

Following the routine reports of the officers and standing committees, S. W. Ashe, educational and welfare department, General Electric Co., Pittsfield, Mass., presented a paper on "Strains, Sprains and Burns". In this paper the author emphasizes the necessity for an efficient dispensary for the treatment of minor injuries. In the ensuing discussion, one of the speakers asked if men afflicted with hernia, or rupture, are accepted by the General Electric Co. Mr. Ashe replied that in normal times it is the policy of the company to avoid hiring such men, including those with a tendency toward hernia. Of course, in prosperous times like the present, he explained, such rules can be too strictly enforced. If a man with hernia tendencies is hired now, owing to labor stringency, he is required to sign a release which, although it has no legal standing, reduces the number of spurious claims for compensation.

The New Officers

Foundry Section, National Safety Council

Chairman,
F. G. BENNETT,
Safety Department, Buckeye Steel Castings Co., Columbus, O.

Vice Chairman
F. W. SHEPARD,
Safety Inspector, American Cast Iron Pipe Co., Birmingham, Ala.

Secretary
S. W. ASHE,
Educational and Welfare Department, General Electric Co., Pittsfield, Mass.

In response to a question as to how a man with merely a tendency toward hernia can be identified, a physician representing the Westinghouse Electric & Mfg. Co. briefly described the technical features of the affliction, which he said, results not from injury but from conditions existing from birth.

In response to another question, relating to safety of clothing, Mr. Ashe stated that the General Electric Co. has abandoned the practice of selling such articles direct to its employes, preferring to work through local dealers. In the case of congress shoes, for instance, a stock of approved styles is carried by a local merchant and the men are given tickets by the company which the storekeeper accepts as 20 per cent of the retail price of the shoes. In other words, the company's employes obtain a discount equal to 20 per cent. "Crane and Chain Practices" was the title of a paper presented by F. H. Elam, manager, casualty department, American Steel Foundries, Chicago. Mr. Elam pointed out that every part of a crane must be safeguarded and that the trolley is a specially prolific source of accidents. He recommended a physical examination for cranemen. Annealing chain slings, he said, does not correct faults unless the chain has been overheated, which rarely occurs in foundry practice.

E. B. Morgan, safety engineer, Norton Co., Worcester, Mass., suggested that chain slings are frequently overloaded; he recommended heavier chains or lighter loading to avoid accidents resulting from fatigue of the metal or crystallization. He also said he favored hand-made chain and condemned the practice of bending the link-stock cold.

Are Cable Slings Desirable?

A representative of the American Locomotive Co. recommended the substitution of wire cables for chains, but Mr. Elam pointed out that the cables now available are unsatisfactory for slings owing to their tendency to twist, possibly releasing the hook at a critical moment.

In a discussion on limit switches it was brought out that these devices should be designed so they cannot be reset easily in order to discourage operators from relying on them in making service stops. The limit switch manufactured by the Pawling & Harnischfeger Co., Milwaukee, was described by L. B. Gates, Allis-Chalmers Mfg. Co., West Allis, Wis. A motion was passed instructing the secretary to send out a questionaire on limit-switch designs and crane brakes, the results to be published in one of the bulletins issued periodically by the foundry section.

P. L. Shepherd, American Smelting & Refining Co., said that the question of warning signals on traveling cranes is a troublesome one. He said he had tried motor operated automobile horns, but with indifferent success. W. B. McLain, United States Cast Iron Pipe & Foundry Co., Burlington, N. J., stated he had found large steel gongs to be the most satisfactory.

F. W. Shepard, safety inspector, American Cast Iron Pipe Co., Bir-

(*Continued on page* 481.)

Fire Makes Way for Model Malleable Foundry

The Moline Malleable Iron Co. Erects a Modern Plant in Which Are Embodied the Latest Ideas on the Design of Industrial Buildings

THE awakening of manufacturers to the truth that dark, poorly constructed, and inadequately ventilated factory buildings cause restlessness and dissatisfaction among employes and contribute in a general way to inefficiency, has been responsible for the inauguration of a new era in the design and construction of industrial buildings. An example of the new idea that is becoming more prevalent among foundrymen, is furnished by the decision of the proprietors of the Moline Malleable Iron Co., St. Charles, Ill., to replace the plant destroyed by fire in 1915, with a group of foundry buildings in which the latest and most approved designs were embodied.

Work on the new plant was started almost immediately after the ruins of the old structures had been cleared away, and within 60 days after the destruction of the old plant, most of the steel work and part of the walls of the new buildings were in place. The plant consists essentially of two parallel units, containing the molding floors, furnaces, annealing ovens and shipping rooms. A hard iron room of simple one-story construction connects the parallel structures at one end. The various departments have been arranged so that the work progresses through the plant in a straight line, avoiding doubling back over the path of the material as it passes from the raw to the finished state. This arrangement permits of the use of the railroad siding at one side of the plant for cars of incoming supplies, such as sand, pig iron and other raw materials, and fuel for the furnaces and for the boiler room. The switch at the other side of the plant is used exclusively for handling shipments of finished products and coal for the annealing ovens.

Plant is Well Lighted

A view of the interior of the foundry is shown in Fig. 1. The building is 150 feet in width and the length is over twice that distance. As shown in the illustration, all parts of this extremely wide floor area are unusually well lighted. This is due in a large measure to the peculiar type of Pond roof truss, which permits the use of large areas of window sash near the center of the roof, directly over the point in the building where light is most badly needed. The Pond truss resembles the letter *M* in that the monitor consists of a V-shaped roof, with slanting continuous sash corresponding to the legs of the letter. The detail of the roof construction is indicated in Fig. 2.

The design of the walls and monitor also contributes to the ventilating qualities of the building. The side walls consist of a brick base wall 8 or 9 feet high, with either two or three tiers of continuous sash extending up to the roof. Where there are three tiers of sash, the top and bottom panels are pivoted to provide a means of ventilation, and in the case of the two-tier walls, only the upper tier contains ventilating sash. The side walls in the monitors have two rows of continuous sash, each of which is pivoted.

Fig. 2 is a view of the annealing room. In this building it was necessary to employ a type of roof construction which would permit a clear floor space of 90 feet to accommodate the charging machines for the furnaces. In this illustration, as well as in Figs. 1 and 3, the simple design of the steel work is much in evidence. The details in this respect have been worked out so well that the weight of the structural steel averages less than 11 pounds per square foot of

FIG. 1—INTERIOR OF FOUNDRY SHOWING THE EVEN DISTRIBUTION OF LIGHT AFFORDED BY THE *M* SHAPED MONITOR

FIG. 2—VIEW OF ANNEALING ROOM CLEARLY SHOWING THE DETAILS OF THE DEFLECTION MONITOR, OR POND ROOF TRUSS AS IT IS COMMONLY CALLED

floor area. This is a remarkably low figure for a building of this type.

A view of the assembling and shipping room is shown in Fig. 3. It will be noted that the storage bins at the left have been arranged so that they do not interfere with the light entering from the windows above, thus permitting the workmen at the benches to receive light upon their work from all directions. Artificial light has been provided by means of single high-power incandescent lamps equipped with reflectors. The lamps are spaced at a distance approximately one and one-half times the height of the lamps above the floor. This system of spacing has given the best results, as it reduces to the minimum the chance for shadows.

Provision for Heating

Heating flues and piping of all kinds have been distributed in such a way that they do not interfere with the movement of the workmen. The heating flues are suspended from the roof purlins at a height several feet below the trusses, so that the distributing outlets which are spaced at frequent intervals are sufficiently high to allow the hot air to circulate with the cooler air before reaching the breathing zone of the workmen. The pipes used for conveying water, gas, air, etc., are suspended from the roof trusses by means of U-bolts or stirrups.

Clay and sand forms the floor of the molding room, but main aisles of concrete have been provided to insure safety in carrying the ladles, and to contribute to the general cleanliness of the plant. The floor of the assembling and shipping room is of heavy matched wooden flooring, while portions of the annealing room have

FIG. 3—A VIEW OF THE ASSEMBLING AND SHIPPING ROOM

concrete floors. The plant was designed by Frank D. Chase, industrial architect and engineer, Chicago.

The Moline Malleable Iron Co. was established in 1869, at Moline, Ill. The principal product of the company is detachable drive chain, which is made up of malleable iron links. The first foundry was destroyed by fire in 1893, and in the same year another plant was built at St. Charles, Ill. The second plant suffered the same fate as the first, when in August, 1915 it was completely destroyed. The officers of the company are: T. S. Fauntleroy, president; R. R. Fauntleroy, secretary; Geo. Ainsworth, treasurer; P. M. Davis, general superintendent.

Making Alloy Castings to Withstand Air Pressure

By S D Sleeth

BRASS and bronze are recognized as metals adapted especially to withstand internal air pressure, and this paper will, therefore, be confined to the use of such alloys. Density and strength are the two qualities that go to make up a metal suitable for the retention of air or other gases under pressure and while strength may be secured through proper design, density is that elusive will-o-the-wisp which we chase for a while in one direction and think we have captured, only to find that it has eluded us and we must look for it elsewhere.

This leads us then to the conclusion that there can be no hard and fast rule whereby this desirable quality of density can always be obtained, probably because of the fact that there are so many variables that enter into the process and that they cannot always be under our control. To enumerate some of these variables, we have the design of the article to be case, the design of the pattern with reference to its position in the flask, the composition of the alloy, the treatment of the metal in the furnaces, and the temperature of the metal when being poured. Each item in this list is worthy of extended discussion, but time will not permit of more than a cursory glance at each subject.

We shall begin with the design of the article to be cast. This has a very important bearing upon the ultimate success of the casting. The designer should bear in mind the desirability of having all cross sections of approximately equal thickness in order to prevent draws at heavy portions. If this is not possible, access to all large sections should be allowed for the use of chills to prevent such draws. If the cored cavities are large the cores will, themselves, act as chills. Fillets should be as small as possible in order that excessive masses of metal shall not be concentrated at one point.

In laying out patterns, the patternmaker must be governed by several things. He must know what chills are to be used so that large chilled surfaces may be placed in a vertical position in order to prevent the metal kicking off these surfaces. He must know what parts are to be clean, such as valve seats, etc., and to what parts loose sand may be allowed to flow if any be found in the mold. Such unimportant parts should be placed high in the cope and the loose sand will flow to them on top of the metal. A clean mold, however, is absolutely essential to good tight castings. An exceptionally clean casting may be obtained by gating it from another castings which will itself take all the dirt.

Importance of Proper Gating

On the use of chills, the following may be taken as an almost universal law: Use chills on all enlarged sections in close proximity to smaller sections and connected thereto. If the sections are exceptionally large, use a sinking head on top of the large sections. Gate your molds with a heavy upright pouring gate as near to the pattern as possible. The gate leading from the pouring gate to the pattern should be made large at the pouring gate and then reduced sharply into the pattern. If it is large where it joins the pattern, in all probability it will show a draw, in the casting at the gate. As a rule, it is better to gate in a light part of the casting than in a heavy portion. If a sinking head be used it should be placed on the heavy part.

As regards the alloy to be used, the following compositions have been tried and found satisfactory for the purpose intended:

METALS.	NO. 1 ALLOY PER CENT.	NO. 2 ALLOY PER CENT.	NO. 3 ALLOY PER CENT.
Copper	72.50	82.00	83.00
Tin	1.75	7.50	11.50
Zinc	19.25	4.75	4.00
Lead	6.50	5.75	1.50
Total	100.00	100.00	100.00

No. 1 alloy is used for ordinary castings, such as cocks, pistons, bushings, etc. This alloy is easily machined, but is not intended for use with very high pressures. No. 2 and No. 3 alloys are intended for use with high pressures and are harder to machine in proportion.

As might be expected, the treatment of the metal in the furnaces is of vital importance. If proper allowance for oxidation of zinc, etc., is not made the alloy intended will not be produced. Furthermore, the metal must be taken from the furnace as soon as it reaches the proper heat, for if allowed to soak in the furnace, it will take up gases and the castings made from it may be porous. In certain packing ring mixtures, we consider this item so important that we use an alarm clock to insure the metal being poured off at exactly the proper moment.

The temperature at which the metal should be poured into the molds is important and no doubt many castings are lost due to carelessness in this matter. If poured too cold it is almost impossible to obtain solid castings, especially at the gate. On the other hand, if poured too hot, the castings may be porous throughout. Great care must be taken to see that no aluminum gets into the mixture, as a very small percentage of it will cause the castings to leak. Antimony and iron will do the same, but not to so great an extent. Aluminum has a very peculiar action on the metal. The castings will look solid and will not show a draw, but when put under pressure will leak all over. It is one of the most dangerous metals around the brass foundry. Antimony does not act as quickly as aluminum, but has about the same effect if used long enough in the mixture. You can start out with a small percentage and it seems to do no harm, but if used until it is mixed with all returned material, such as turnings, gates, etc., the castings will become porous.

In conclusion, it may be said that solid castings of a density to withstand air pressure can be obtained only by the exercise of the greatest care from the design of the article to the pouring of the metal into the mold. Even then failures will sometimes happen and final success can be obtained only through experiment and the adaptation of the various methods to the article under consideration.

Presented at the annual meeting of the American Institute of Metals, Sept. 11-15, 1916, Cleveland, O. The author is superintendent of foundries, Westinghouse Air Brake Co., Wilmerding, Pa.

The Campbell Mfg. & Foundry Co. has been organized at Muskegon, Mich., with $100,000 capital. The company will have H. D. Campbell, Cleveland and

Manistee, Mich., as president; J. D. A. Johnson, vice president; John Q. Ross, secretary, and Charles B. W. Cunningham, treasurer. A main building of steel and concrete construction, 19 x 180 feet, with projections for core ovens, cupola and sand and storage bins, will be erected at once. Two 30-foot side bays also will be built. The estimated cost of the building is $25,000. The principal product of the foundry will be gray iron castings.

Analyses of Aluminum Castings for Zeppelins

According to a French exchange, the alloys used in the construction of various parts of a Zeppelin brought down in France, analyze as follows:

	Angle brackets, per cent
Aluminum	90.27
Zinc	7.80
Iron	0.45
Silicon	0.37
Copper	0.73
Tin	0.11
Manganese	0.27
Nickel	Trace

	Channel sections, per cent
Aluminum	88.68
Zinc	9.10
Iron	0.43
Silicon	0.49
Copper	0.70
Tin	0.15
Manganese	0.45
Nickel	Trace

	Braces, per cent
Aluminum	99.07
Zinc	0.13
Iron	0.38
Silicon	0.36
Copper	0.06
Tin	....
Manganese	....
Nickel	Trace

The braces approach commercially pure aluminum in analysis, while the other parts are alloys of aluminum, zinc, copper and manganese. The absence of magnesium is a surprise, since this metal has been employed extensively in making alloys for aeroplane castings.

The Hershfield-Piper Foundry & Machine Co., Chicago, has increased its capital stock from $75,000 to $100,000 and changed its name to the Kincaid Foundry & Machine Co. A plant, including a foundry, 45 x 135 feet, a machine shop, 45 x 105 feet, and storage, pattern room and office, two stories, 80 x 20 feet, will be erected at Kincaid, Ill. The equipment has been provided.

The Findlay Steel Casting Co., Findlay, O., recently incorporated with $200,000 capital stock, will shortly erect a plant of steel construction. The following equipment will be required: Crane, compression sand mill, emery grinding stand, sand blast machinery, air tools for foundry and cleaning room, scales and other foundry appliances. Open hearth and electric steel castings will be made. E. J. Edwards is president of the company, E. T. Pelton, vice president and secretary, and Harry A. Tilden, treasurer.

Fatalities in Foundries Must Be Eliminated

(*Continued from page* 477.)

mingham, Ala., introduced his paper on "Eye Protection" in an original manner by first appearing with the thick, smoked glass and cane of the blind man. The unusual danger of infection as an aftermath of eye accidents was emphasized by Mr. Shepard. He also took up the question of abnormal or defective vision, which, he said, is more prevalent than most people realize and is one of the greatest causes of industrial accidents.

The discussion of Mr. Shepard's paper was initiated by W. E. Lewis, United States Cast Iron Pipe & Foundry Co., Anniston, Ala., who asked what type of goggles are suitable for work around pipe pits where the men must see sideways. Mr. Shepard replied that some such men, and others, cannot wear goggles satisfactorily; in his plant, he explained, goggles are required only on men handling metal, working at grinding wheels, chipping, or otherwise engaged at tasks specially hazardous to the eyes.

L. D. Burlingame, superintendent, Browne & Sharpe Mfg. Co., Providence, R. I., stated that most of the objection to goggles comes from men who wear ordinary spectacles and do not like double glasses. "We have eased off on the goggle requirements in such cases," he said, "and are watching results." Although Mr. Burlingame suggested that specially ground, corrective lenses are too expensive for shop goggles, other speakers, including Mr. Shepard, contended that this is the only solution of the problem of protecting the eyes of workmen with abnormal vision.

Back With the Saloon

Two papers, "Alcohol vs. Safety", by Dr. H. P. Hourigan, Larkin Co., Buffalo, and "Foundry Sanitation", by J. F. Alexander, secretary, Metal Trades Safety Association, Toronto, Ont., were discussed together. Dr. Hourigan's paper constitutes a powerful argument against the liquor traffic, based purely on records of industrial accidents. Mr. Alexander's paper points out the essential elements of foundry sanitation, the greatest of which, he said, is ventilation.

The question of alcoholism came in for considerable discussion. R. G. Williams, safety engineer, Norton Co., Worcester, Mass., told of the success achieved by the establishment of milk stations in the Norton plant. At present, he said, 100 gallons of buttermilk and 100 gallons of sweet milk are being distributed daily. Drunkenness has shown a marked decrease. Other speakers pointed out that it is absolutely essential to provide a substitute for the corner saloon, in the shape of lunch rooms, club rooms, etc., if intemperance is to be fought successfully. A tribute was paid to the great pioneer work of the late Thomas D. West in starting the industrial propaganda against liquor. Mr. West's paper on this subject, read before the American Foundrymen's Association in 1914, was referred to as a classic.

First Safety Exhibition

The first national exhibit of safety appliances was held at the Detroit armory, in connection with the meetings of the congress. The exhibition was under the direction of C. E. Hoyt, Lewis Institute, Chicago. Fifty-six exhibitors participated in the show. In addition to modern safety devices, several companies displayed photographs, charts, lantern slides and moving pictures, showing methods of promoting safety and preventing accidents.

Among the exhibitors connected with the foundry and metal trades were the following: Allen Mfg. Co., Hartford, Conn., safety set screws; American Abrasive Metals Co., Detroit, anti-slip floor plates and stair treads; Chicago Eyeshield Co., Chicago, goggles; Commonwealth Steel Co., Granite City, Ill., steel foundry safety devices; Detroit Fuse & Mfg. Co., safety switches; Draeger Oxygen Apparatus Co., Pittsburgh, helmets and pulmotors; F. A. Hardy & Co., Chicago, goggles; Julius King Optical Co., New York, goggles; Life Saving Devices Co., Chicago, lungmotors; Mine Safety Appliances Co., Pittsburgh, safety appliances for mines and industrial plants; Multi-Metal Separating Screen Co., New York, sand blast helmets; New Jersey Zinc Co., Palmerton, Pa., welfare work; Norton Co., Worcester, Mass., safety grinding wheels and wheel stands; Oliver Machinery Co., Grand Rapids, Mich., safety devices for wood-working machinery; Otis Elevator Co., New York, elevators and skip hoists; Respiratory Apparatus Co., Chicago, artificial respiration apparatus; Jos. T. Ryerson & Son, Chicago, safety stair treads; R. P. Smith & Sons Co., Chicago, congress shoes for molders; Strong, Kennard & Nutt Co., Cleveland, goggles; United States Bureau of Mines, Washington, D. C., safety devices for metal mines; Walsh Press & Die Co., Chicago, punch press guards; Wheeler & Holcomb, Chicago, asbestos clothing; National Safety Council, Chicago, safety photographs, charts and models.

How Old Metal is Reclaimed in a Large Plant

The Western Electric Co. Has a Systematic Method of Handling the Vast Tonnage of Scrap Metal Which Accumulates at Its Hawthorne Works Each Month

By J M Bateman

IN large manufacturing plants where vast quantities of raw material are consumed, the task of economically disposing of waste incident to the manufacturing operations becomes a serious problem. At the Hawthorne works of the Western Electric Co., Chicago, where materials approximating $1,500,000 in value are used each month, old metal is being reclaimed by means of a system that is said to have proved very satisfactory. The following figures, which represent approximate monthly averages of the large items of junk disposed of to outside concerns, will possibly give a clearer idea of the amount of material involved:

Brass, 100 tons; copper, 180 tons, including 125 tons from the cable, rubber and insulating shops; German silver, 17½ tons; iron and steel, 89 tons; solder skimmings, 4 tons, and lead, 833 tons.

A vast number of the parts used in the manufacture of telephone apparatus are punched from sheet metal, brass, iron or German silver. This operation, of course, leaves as waste a certain portion of the original sheet or strip. Representative samples of waste of this nature are here shown in Fig. 2. All brass, copper, German silver, etc., is kept separate by material in the operating departments, and sent to the by-products department, where it is baled in the Minich baling press, shown in Fig. 3. This electrically operated press

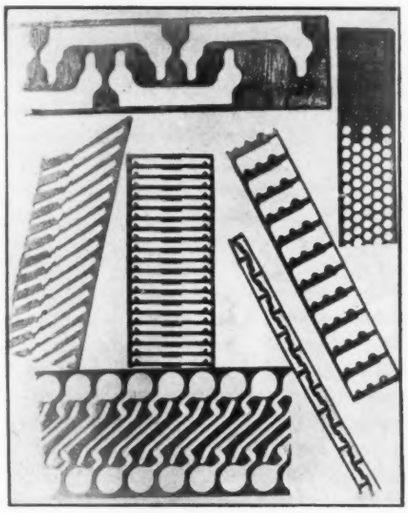


FIG. 2—WASTE PORTIONS OF SHEET METAL FROM WHICH PARTS OF TELEPHONE APPARATUS HAVE BEEN PUNCHED

compresses the waste material into a bale approximately 2 feet wide, 2½ feet thick, and 3 feet long, which, when completed, weighs approximately 1,100 pounds, depending to a large extent upon the shape and size of the material used. A Logemann hydraulic bundling press, which has recently been installed, is especially adapted to work of this kind, for not only is it easy to operate, but junk baled in a press of this type commands a comparatively high price, and the bales are compact and readily handled, weighing only about one-tenth as much as those formed in the Minich machine. The baling machine handles the larger pieces of scrap material, while the chips, turnings and sweepings from the machine departments are taken care of in a different manner.

The apparatus used for separating the dust and dirt from the small chips and metal shavings and the machine used in separating the iron from the brass are shown in Fig. 4. The mechanical separator, shown at *A* is very simple in construction, consisting simply of a sifter which is oscillated by a small motor. Thus, the dust and dirt are separated from the usable chips and shavings. The magnetic separator used in separating the iron from the brass in the sweepings is shown in the foreground of Fig. 4. The revolving drum, *C*, which has an annealed iron face, is driven by a small motor, shown at *D*.

Within the drum is a series of powerful electro-magnets, which extend in the form of an arc approximately from the bottom of the hopper, *E*, to a point

A paper read at the American Institute of Metals Convention, Cleveland, Sept. 11-15, 1916.

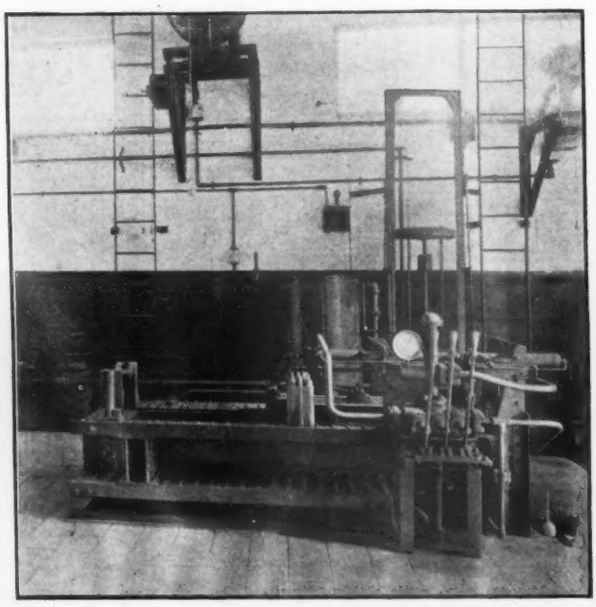


FIG. 1—HYDRAULIC BUNDLING PRESS

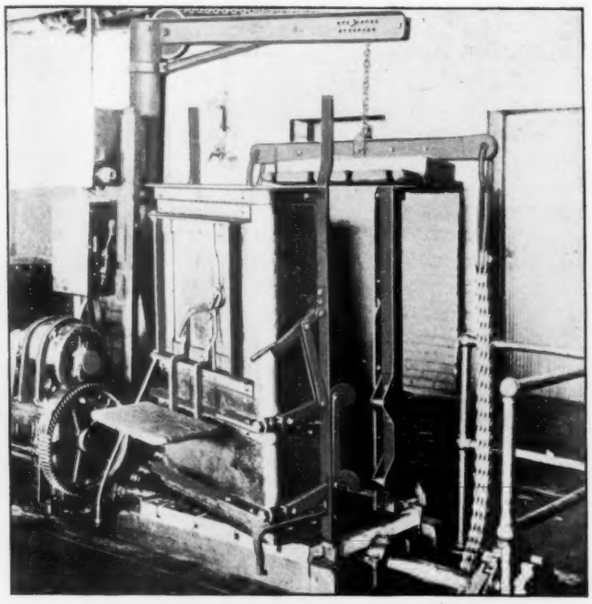


FIG. 3—MOTOR-DRIVEN BALING PRESS

directly below the shaft on which the drum revolves. The chips and shavings shoveled into the hopper, travel down the chute, which is at all points parallel to the periphery of the revolving drum. The brass shavings travel down this chute into box *F*, while the iron chips, which may have been mixed with them, are attracted by the magnets to the soft iron face of the drum, where they are held until they reach a point directly above the iron pan, *G*, where they are released by the magnets. Both kinds of chips are then put up in sacks for convenient handling.

The scrap cable is first placed in the gas-heated, brick-encased ovens, *A*, Fig. 5, where it is heated until the lead sheath has been melted and the paper insulation has been burned from the wire. The molten lead is run off into the refining furnace, *B*, where it is automatically separated from the paper ash and other impurities which it contained when taken from the melting furnace. Before the present apparatus was installed the molten lead was made into pigs direct from the melting furnace, which necessitated an additional handling, as it had to be refined before being fit for sale. After the refining operation is completed, the molten lead is drawn off into the molds, shown at *C*. It will be noted that the molds are mounted on a turntable, so that one man can manipulate the levers *D* and *E*. The lever *D* opens the gate and allows the metal to flow into the mold, while lever *E* turns the table upon which the molds are mounted. As the filled molds pass around toward the left they travel under running water, which cools the lead so that the molds, which are pivoted, can be tipped and the pigs of lead extracted. While a portion of this lead mixture can be used in the press room, much of it contains too great a percentage of impurities to meet the severe requirements demanded in the manufacture of cable, and therefore it is sold to refining companies to be further purified.

The copper wire remaining in the furnace after the lead has been run off is placed in the Logemann press and compressed into brick form before being sold.

Information on the Operation of the Cupola

By W. J. Keep

Question: — Referring to several of your recent articles on "Dull Iron" published in THE FOUNDRY, I would like to know why it is better to use the bottom row of tuyeres only, than both the top and bottom rows. Is a height of 15 inches above the tuyeres about correct for the coke bed? I have always understood it to be 18 to 24 inches. If two rows of tuyeres were used, would it make any difference in the height of the bed? Should the air pressure for two rows of tuyeres be the same as for one? What are the limits in weight and dimensions of pig iron and scrap that are to be charged in a 60-inch cupola? I understand there is a certain zone in the cupola where melting conditions are ideal and I would like to have some information on this phase of the subject. If the bed is too low, and also too high, what effect does it have on the speed of melting and the temperature of the iron?

Answer:—I think that this question was answered a short time ago and a reply was published in THE FOUNDRY. My reason for objecting to the use of two rows of tuyeres in a cupola making small heats is that they require a greatly increased coke bed and at the end of the heat the upper row of tuyeres blows air over the iron and has a tendency to cool it. If your melter will close the damper over the top row of tuyeres when the last charge has nearly reached them, the upper tuyeres will do no harm. You can readily experiment to ascertain the results of one and two rows of tuyeres by running one week with both rows of tuyeres and then one week with the upper row closed with fire brick and clay. The theory is that the excess of air from the lower tuyeres forms carbonic oxide, which would generate heat if it had more air. Therefore, why is it not advisable to blow in a little more air through the lower tuyeres? Some cupolas have a half dozen rows of tuyeres, each succeeding row being smaller than the one underneath. Another reason assigned for the use of the upper row of tuyeres is that it starts the melting of the iron above the lower row and, therefore, melts the iron faster than with one row only. While this may be true, nevertheless it has been my experience that in heats of an ordinary size, that one row of tuyeres will melt the iron much more rapidly than two rows and that one will obtain a lower fuel ratio. The lowest line which will give hot iron all through the heat will melt fastest with the least consumption of fuel. The total air per ton of coke burned is the same in any case and more air can be forced through two rows than one, unless the inside total area is the same. Three thousand pounds of iron to 275 pounds of coke is good melting, not including the bed, and you generally can make the bed charge of iron 4,800 pounds. The melting zone is within two feet of the tuyeres if you use one row.

FIG. 4—APPARATUS FOR SEPARATING IRON AND BRASS

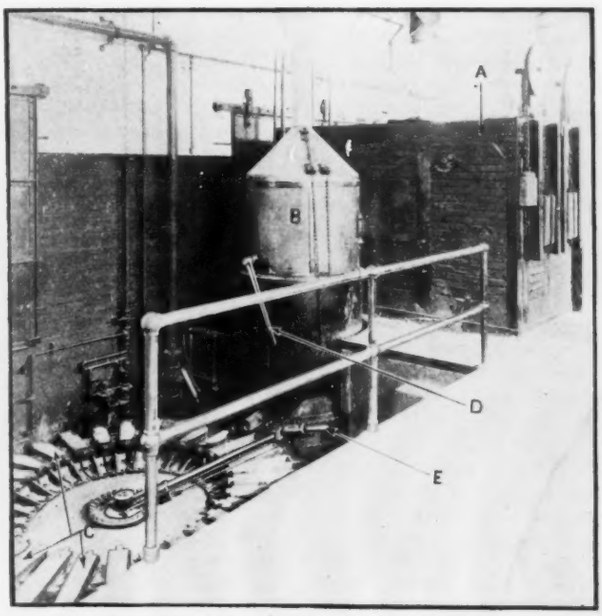


FIG. 5—MELTING FURNACE IN WHICH LEAD IS RECLAIMED

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Prosperity and Progressiveness

IN THESE times of plenty, when every foundryman is face to face with the difficult problem of increasing production to keep pace with the demand for castings, it is not uncommon to hear the wail of the calamity howler. Enthusiastic business men are urged to go slow, and to take care lest they waste the resources on which they must depend when the present wave of activity is over. There is an underlying feeling that America cannot stand prosperity.

Granting that sound business principles make proper allowances for all possible pitfalls, and assuming that the average foundryman conducts his affairs along the approved ideas, we can see no cause to be alarmed at the course now pursued by the men of this industry. On the other hand, there is every reason for optimism, for under the pressure of unprecedented activity, the foundries are being operated according to a policy which looks far into the future. Foundrymen have not been swept off their feet by the promise of ready profits, but by earnest study are endeavoring to turn the experience of the past to profitable account in the future. Obstacles encountered and defeated in 1916 will not present the same difficulties in 1917. Managers are devoting their attention to efficiency, better working conditions, constructive cooperation, and safety. Progressiveness is the watchword, and because American foundrymen are so foresighted, they will emerge from the present abnormal era better qualified to meet any emergency that may arise.

Trade Outlook

ALL outward signs of foundry labor difficulties are diminishing rapidly. During the past month there has been a tendency toward greater production, although car shortage and scarcity of labor have hampered the delivery of raw materials. The feature of the last few weeks has been the heavy buying of pig iron, accompanied by a rapid rise in the prices of all grades of iron and coke. This condition has been created by a tremendous export and domestic demand for steel-making iron and by delayed action on the part of foundrymen to cover for their requirements. Shortly after the second week of October, when buyers figured actively for large tonnages, the price of foundry iron soared by leaps and bounds, and high prices have been firmly maintained, especially at Chicago and Buffalo. Basic at Pittsburgh, quoted at $19.45 at this time last month, is now held at $20.95; No. 2 foundry, during the same period has jumped from $19.70 to $21.95; and bessemer is quoted at $24.95 as against $22.95 a month ago. Still more remarkable, however, is the rise in the price of foundry coke from $3.15 to from $7 to $7.50, for prompt delivery. Contract foundry coke is quoted at $5.25. No. 2 foundry iron is quoted as follows: Pittsburgh, $21.95; Chicago, $19.50; Cleveland, $20; Buffalo, $20; Philadelphia, $20.50, and Birmingham, $15.50. Malleable iron is quoted at $19.50, Chicago, and Lake Superior charcoal iron is held at $20.75, Chicago. Extremely high prices have been reported for small lots of iron and coke for prompt delivery, these exceptional transactions making it difficult to gage the market. Present indications point toward prices even higher than those that are now prevailing.

Reviews Labor Situation

The Mechanics & Metals National Bank of New York, in a recent market letter says:

"Since March the labor situation has developed so many individual crises that it has become unmistakably the most important subject of the day as affecting the trade and commerce of the country. One after another disputes have arisen between employers and employed; in the great majority of cases these have resulted in wage increases or their equivalent.

"The unusual circumstances of the time have made it seem advisable to accede to labor it demands, and wages are now on a higher plane than they have ever been before. No more complicated problem, however, confronts the American people today than that which deals with our industrial position when Europe's war ends. And nothing more complicates the problem than the constant striving of American labor to produce less and earn more at the very time that European labor is learning how to increase its production and do with very much less."

Describes Sand-Cutting Machine

A 24-page catalog, showing the application of the sand-cutting machine which it manufactures, has been issued by the Sand Mixing Machine Co., 52 Vanderbilt avenue, New York. Interesting views of the plant of the Allyne-Ryan Foundry Co. are included, in which several of these machines are employed for cutting-over the tremendous tonnage of sand used in this shop. Typical molding floors in the plant of the Remington Typewriter works, showing the employment of one of these sand-cutting machines, also are included.

The Mathews Gravity Carrier Co., Ellwood City, Pa., is increasing its capacity. The company is erecting a building for assembling and shipping material and a new storage house, 80 x 80 feet, and a forge shop, 40 x 60 feet, are under course of construction. Considerable equipment has been purchased.

The Aluminum Castings Co., Cleveland, announces through President E. E. Allyne it has just closed for 18 acres at Independence road and E. Forty-ninth street, in that city, and has started construction of five factory buildings which will be built by the Austin Co., Cleveland. The contract stipulates completion by Nov. 24.

The Erie Foundry Co., Erie, Pa., manufacturer of steam drop hammers, galvanizing equipment and the like, is building an addition, 40 x 200 feet, to its machine shop. The company has purchased some new equipment, including planers, boring mills and drill presses, which will be put into operation about Dec. 1.

Personal

R. A. Bull, manager of production in charge of operations of the Commonwealth Steel Co., Granite City, Ill., has resigned, effective Nov. 1. Mr. Bull was president of the American Foundrymen's Association from 1914 to 1916.

William H. Cummings, who has had considerable experience in sheet metal and skylight work, has become associated with the glazing department of the Asbestos Protected Metal Co., Pittsburgh.

Foundry Rebuilt

The North East Foundry & Machine Co., North East, Pa., whose plant was damaged by fire last July, a few days after it was put into operation, has rebuilt its works and now is engaged in the manufacture of a diversified line of gray iron and semi-steel castings. A 54-inch Whiting cupola, built by the Whiting Foundry Equipment Co., Harvey, Ill., is housed in a steel frame building, 80 x 100 feet. The company was incorporated Oct. 3, by Dr. J. H. Finerty of Buffalo, president; E. A. Finerty, secretary; W. G. O'Malley and F. G. Pottmeyer, vice president and general manager. Mr. Pottmeyer formerly was connected with the Pittsburgh Iron & Steel Foundries as assistant general superintendent of its plant at Midland, Pa. Mr. O'Malley is works manager of the Pittsburgh Crucible Steel Co., Pittsburgh. The company is in a position to promise early deliveries.

The Burnside Steel Co., Chicago, recently incorporated with $100,000 capital stock, is erecting a plant at Kimbark avenue and Ninety-second street. The main building will be steel, 80 x 200 feet, with an office and pattern storage building, 30 x 50 feet. The company will manufacture steel castings and a Tropenas side-blow converter will be installed. The offices are at 548 Railway Exchange building. H. F. Wardell is president, George L. Pollock, vice president and treasurer, and C. S. Daniels, secretary.

Herman A. Holz, 50 Church street, New York, manufacturer of the Brinell meter and other precision instruments for industrial, scientific and military purposes, will open a store on the main entrance to 50 Church street to display his instruments.

Commercial Register Issued

The twenty-fifth annual edition of Hendricks Commercial Register of the United States, which has just been issued, rounds out a quarter of a century in the life of this standard publication. The work is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. It contains about 350,000 names and addresses, with upward of 45,000 business classifications. Full lists are included of producers, manufacturers, dealers and consumers, listing all products, from the raw material to the finished article, together with the concerns handling these products, from the producer to the consumer.

There are 1,512 pages of text matter. The index of the contents covers 149 pages and includes over 50,000 trade references. A list of trade names, brands, titles of identification, etc., is published for the first time and numbers 202 pages. This list furnishes ready reference to distinctive products manufactured by firms listed in the work.

Steel Casting Plant Sold

The steel foundry and machine shop of the New Jersey Steel Co. has been sold to the Nagle Steel Co., Pottstown, Pa. The purchase price was not given. It is said that the new owners will operate the plant as soon as necessary repairs are made and new equipment installed for the manufacture of steel castings. The plant has been idle for several years. Last winter the foundry equipment, machine tools, etc., were sold at private sale by the bondholders' protective committee, who had previously purchased all the assets of the original company at foreclosure sale. The plant is situated on the main line of the Pennsylvania railroad. The foundry building is 600 feet long and 50 feet wide. The plant has a 25-ton open-hearth furnace, power plant, office buildings, laboratory, pattern shop, etc.

The brass-back bearing department of the Doehler Die-Casting Co. has been removed from the Brooklyn, N. Y., plant to a new building, housing a foundry and machine shop, at its Toledo, O., plant.

The Clarage Fan Co., Kalamazoo, Mich., manufacturer of steel plate fans, has established a branch office at 123 West Madison street, Chicago, in charge of L. O. Monroe.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

Charlotte Bros., Blackstone, Mass., will build a foundry.

The Holland Furnace Co., Holland, Mich., will erect a foundry, 60 x 230 feet.

The Detroit Bearing & Casting Co., Detroit, Mich., will enlarge its plant.

The Roeller Foundry Co., Bay City, Mich., will erect a one-story addition, 50 x 150 feet.

A foundry will be built at Corry, Pa., for the United States Radiator Corporation.

The Flather Foundry Co., Nashua, N. H., contemplates erecting a one-story, 20 x 100-foot foundry addition.

The Kokomo Brass Works, Kokomo, Ind., will build a gray iron foundry, 120 x 250 feet, at a cost of approximately $30,000.

The Fay Foundry Co., St. Joseph, Mich., will build an addition to its foundry which will double the present capacity.

I. Kaplan, 119 Illinois street, Detroit, will build a foundry, 40 x 105 feet, at a cost of $7,000.

The Pennsylvania Engineering Works, New Castle, Pa., will build a foundry addition, 100 x 280 feet.

The American Steel Foundries contemplates erecting an addition to its plant at Franklin, Pa.

Bids are being received for erecting a $15,000, one-story foundry, 140 x 160 feet, for the Elliott Co., Jeanette, Pa.

The Reliance Foundry Co., Richmond, Ind., will erect a foundry on North Eighth street at a cost of $4,000.

Charles Jackson & Sons, Toronto, Ont., have incorporated with $40,000 capital and have been authorized to carry on business as engineers, iron founders, machinists, etc.

The Pulaski Foundry & Mfg. Co., Pulaski, Va., has been incorporated with a capital stock of $25,000. Robert Bunts is president of the company.

The Oelkers, Pfindlar, Sester Foundry Co., East Peoria, Ill., has been incorporated at $8,000 by Harry Pfindlar, B. W. Belsley and Henry Oelkers.

The North East Foundry & Machine Co., North East, Pa., has been incorporated with a capital of $25,000 by Edmund A. Finerty, Frank G. Pottermeyer and others.

A foundry at Oxford, N. J., which has been idle for about two years, has been placed in operation by the Oxford Foundry & Machine Co.

The Bradley Foundry Co., Kankakee, Ill., has been incorporated with $5,000 capital by J. F. Cady, F. H. Seidel, O. Gommell and Edward Unruh.

The Lynchburg Foundry Co. is remodeling its plant at Anniston, Ala., which has been closed since the autumn of 1915, preparatory to placing it in operation early in 1916.

The Chatfield Machine & Foundry Co., Escanaba, Mich., has been incorporated with $25,000 capital and has taken over the business of the Chatfield Brass & Iron Works.

Construction has been started on an addition to the plant of the Imperial Brass Mfg. Co., 1200 West Harrison street, Chicago. This extension will double the floor space, giving a total of 150,000 square feet.

The Ideal Foundry Co., Grand Rapids, Mich., is building a pattern shop, two stories and basement, 40 x 100 feet, of reinforced concrete and brick construction.

The Steam Appliance Co., North Burnham and Sixty-third streets, West Allis, Wis., will build an addition to its foundry, 50 x 62 feet.

The contract has been awarded for the erection of a $10,000 addition to the foundry of the Connellsville Machine & Car Co., Connellsville, Pa.

The Bernstein Mfg. Co., Philadelphia, contemplates making alterations and erecting additions to its foundry at Third street and Allegheny avenue.

The Elmira Foundry Co., Elmira, N. Y., will increase its capital stock from $50,000 to several times this amount and will enlarge its foundry.

The Yost Bros. Co., Creighton, Pa., will build a one-story, 50 x 100-foot foundry and machine shop at a cost of approximately $20,000.

The Standard Malleable Iron Works, Muskegon Heights, Mich., has increased its capital from $100,000 to $250,000 and will build additions to its plant.

The plant of the Braddock Machine & Mfg. Co., Braddock, Pa., has been purchased by Robert G. Tener, formerly assistant treasurer and a director of the United Engineering & Foundry Co., Pittsburgh.

Plans are being prepared for a $50,000 foundry, one and two stories high, to be erected for the Troy Engine & Machine Co., Troy, N. Y. Fletcher & Thompson, Bridgeport, Conn., are the engineers.

The contract has been awarded for a one-story, 65 x 122-foot manufacturing building and a one-story foundry addition to be erected for the Gorham Mfg. Co., Providence, R. I.

The contract has been awarded by the Waterbury Farrel Foundry & Machine Co., Waterbury, Conn., for a brick and stone, mill-construction, six-story plant, 104 x 200 feet.

John H. Osborn and Charles G. Holmes have organized the Osborne Casting Co. and are erecting a $20,000 foundry and pattern shop at Layard avenue and the C. & N. W. tracks, Racine, Wis.

Myron H. Spades, 110 South Dearborn street, Chicago, will erect a foundry, 133 x 266 feet and a forge shop, 50 x 160 feet, at a cost of $45,000, for lease to the Accurate Engineering Co., 2418 West Fourteenth street.

The Houghton Malleable Castings Co., Toledo, O., is remodeling a foundry at Woodville street and the Wheeling Belt railroad. Property adjoining the foundry has been purchased for further additions.

The Ohio Mold & Foundry Co., Cincinnati, recently incorporated with $100,000 capital stock to engage in the manufacture of ingot molds, is negotiating for the old plant of the Lane & Bodley Co., in that city. The incorporators are C. B. Matthews, H. T. Klein, A. C. Gallagher, F. H. O. Fredericks and H. M. Bradley.

Davidson & Weiss, architects, 53 West Jackson boulevard, Chicago, are taking bids on a plant, including a gray iron foundry, machine shop, pattern shop and other structures, which will cost $150,000.

The Price Mfg. Co., Chattanooga, Tenn., has been incorporated to engage in the manufacture of castings, car appliances and other foundry products. The company is capitalized at $95,000 by S. S. Price, W. D. Moon, W. S. Rice, F. J. Miller and J. H. Cantrill.

The Talladega Pipe & Foundry Co., Talladega, Ala., has been incorporated with a capital stock of $20,000 to engage in the manufacture of cast iron pipe. The incorporators are S. C. Oliver, R. T. Hicks and others.

The Appomattox Iron Works & Supply Co., Petersburg, Va., has been incorporated with $100,000 capital to operate a foundry and machine shop and conduct a wholesale and retail supply business. The incorporators are A. L. Steere, C. H. Steere and L. B. Shackelford.

The contract has been awarded by the Studebaker Corporation, South Bend, Ind., for erecting a foundry and machine shop at a cost of $1,500,000. The machine shop will be 300 x 900 feet and the foundry will be 150 x 1,100 feet and will have a daily capacity of 250 tons.

The Ford Motor Co., Detroit, is erecting a foundry and blacksmith and machine shop at 4317 Broadway, Chicago. The estimated cost is $60,000. The Kling Brothers Engineering Works, Chicago, manufacturer of boiler shop and steel fabricating tools, will erect a foundry.

W. H. Christy, R. S. Irwin and H. S. Chambers have incorporated the Lawrence Foundry Co. with a capital of $25,000. The new company has purchased the plant of the Burrows Foundry Co., Ellwood City, Pa., and is building an addition and installing equipment which will more than double the capacity.

The Gartland & Carroll Foundry Co., recently incorporated by T. H. Gartland, John J. Carroll and J. C. Haswell with $100,000 capital, will erect a foundry, 84 x 300 feet; a finishing building, 100 x 100 feet; and a storage building and office, on West Monroe street, Sandusky, O. The estimated cost of this construction is $30,000.

The Stewart-Warner Speedometer Co., 1828 Diversey Parkway, Chicago, has awarded contracts for an iron foundry, 122 x 530 feet; a core building, 70 x 80 feet; a brass foundry, 100 x 100 feet and a storage building with 5,000 feet of floor space, to be erected at Beloit, Wis. The estimated cost of this construction is $300,000.

The T. E. Henry Furnace Co., Cleveland, will be reincorporated with a capital of $150,000 under the name of the Henry-Miller Foundry Co. The company operates the Medina Foundry Co., Medina, O., with a branch plant at Chagrin Falls, and has recently purchased the works of the Novelty Iron Co., Canton, O. The main office of the company will be at Canton, O.